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AMERICAN WATER WORKS ASSOCIATION

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In this Issue

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22 EAST 40TH ST., NEW YORK

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Defense of Water Supply Works

By Norman J. Howard

IN THESE very serious times it is most desirable that every citizen should have some knowledge of protective measures against hostile enemy action. To this end has been organized in Canada a Civilian Defense Committee based upon the organization established in Great Britain known as the Air Raid Precaution (A.R.P.). This is not directly related to imminence of air attack or invasion, but results from the fact that attack, either from within or without, is a risk which cannot be ignored, particularly in view of events in other countries during the past year and a half. Preparations to meet and minimize the consequence of such attacks can be effective only if made well in advance of their occurrence.

Provincial-wide advisory committees are established throughout the Dominion of Canada to create volunteer civilian organizations to meet emergencies occasioned by war, to protect life and property, to assist the civil powers by co-operating with all police and other law enforcement agencies, to combat subversive activities, to assist in fighting fires resulting from sabotage or other acts of war, to instruct the civilian population in emergency services and to co-operate with and assist all federal and provincial authorities in the performance of duties relative to the objects of this organization. In the United States, national organization is headed by the Civil Defense Administration

A paper presented on June 23, 1941, at the Toronto Convention by Norman J. Howard, Director of Water Purification, Island Filtration Laboratories, Toronto, Ont.

(C.D.A.). This body is provided with an advisory group of military and civilian leaders who advise states and cities how to organize and operate defense measures. The Secretary of War through his personnel, and with the assistance of a civilian engineering group, has prepared a manual of "Protective Construction." In the course of preparation and actually in print are manuals of gas defense and fire defense. Various professional groups such as the A.S.C.E. have organized local or regional committees to instruct and spread information. The A.W.W.A., through its staff, has made available to key water works men and all Section officers, authentic information relative to foreign experiences and advice on planning defense of water works properties.

Canada is at war. Just how close the United States is to war is a matter of conjecture. Generally speaking, water works properties in the United States are in good condition following the years of improvement under P.W.A. or W.P.A. auspices. Defense demands have increased, and in many plants the task of expansion is a highly difficult one, related in part to the problems involved in the priority situation.

Priorities Problems

In recent issues of the JOURNAL, the question of priority is dealt with frankly. There it is pointed out that water works men must not expect continuation of a "free and easy" purchase situation; that they must be prepared for serious difficulties in obtaining materials and must keep as level headed as possible while the period of adjustment is going on.

As a result of defense policies two very difficult problems have arisen, one being associated with a great increase in the demand for water and the other directly connected with the provision of emergency equipment. Even if both of these could be met, which at the present time is doubtful, the question arises as to who should foot the bill. Municipalities, already overburdened by taxation, hesitate about becoming more seriously involved; and it must be admitted frankly that the difficulty of securing equipment is welcomed by not a few. The gravity of involvement, should emergencies arise for which no adequate provision has been made, needs no emphasis at this time; it constitutes a most serious problem because "officially," priority can be invoked only when an emergency arises, and, outside of normal expectancy, who can foretell what the future has in store.

Personnel and Sabotage

Among the gravest problems which must be considered seriously is that of personnel. Legislation to protect the rights of labor has developed to a phenomenal degree. Strikes are called upon the merest pretext, quite often without justification. The loyalty of many connected with the organization of labor, and of many employees is doubtful, regardless of the frequent claims to the contrary. The work of many industries and trades is interconnected. Strikes in all types of defense industries are frequent. Sabotage is not confined to outright acts of destruction. It may take subtle forms of interference with industry or public service.

In recent weeks the public services of some cities were in danger of complete disruption because of strikes, while in New York City transport leaders recently threatened a strike which might have tied up many vital industries, and occasioned far reaching involvements. According to a recent report of an F.B.I. agent: "Disloyal employees are in a better position to commit sabotage and espionage than a non-employee. At all public utility plants, employees and former employees have a complete working knowledge of the plant functions, and are in possession of authentic information which enables them to strike at the vulnerable points of the industry, with which they are familiar." It is for these and many other reasons that so much stress is placed upon the personnel situation in all plants.

Protection Against Sabotage

In reviewing briefly the most logical steps to be taken to guard against sabotage, in addition to that of personnel, it is of interest to point out what has been done in Canada. Protective measures, based upon British practice, have been in effect since the outbreak of war. These had been worked out previously and were put into immediate operation. All visitors were, and still are, excluded from public utility plants, admission being by pass only. These passes are issued only after full investigation; and even employees cannot enter the works without them. Foreign-born employees who had not been naturalized prior to 1922 were discharged. While this may seem somewhat harsh it became necessary following a Dominion order in council. Full control over the delivery of gasoline and oil is maintained. Parcels delivered at the works must be inspected and under no condition opened inside a building. At the outbreak of war,

armed guards were stationed at suitable locations. Wire entanglements, similar to those used in the last war, were erected so that the works are completely enclosed. Elaborate flood-lighting systems were installed, illuminating the works and covering all approaches. The doors on all buildings were equipped with door chains enabling the door to be opened only about four inches for inspection purposes. Admission to buildings is subject to presentation of pass. Heavy wire screens were placed on all windows and in locations where deemed necessary.

These measures naturally involved heavy expenditure and, at the end of the first six months of war, it was found possible to dispense with the armed guard. Hourly patrols of the works have, however, been maintained. In Great Britain, buildings have been protected by sand bags, and glass has been removed from the windows, or, at least, been rendered splinter-proof. Clever camouflaging of water works structures has also been employed successfully.

Other Measures of Civil Defense

In addition to its provisions against sabotage, the civilian defense program can be of material assistance in other respects. The importance of many of these other protective measures has been demonstrated over and over again in the bombed areas.

It is imperative, for instance, that additional cut-off valves be provided at vital points and that all valves in the distribution system be maintained in good working order. Plans of distribution systems should be located at predetermined points, and should be enclosed in fire-proof cabinets. Inter-connection with adjacent supplies has been found particularly valuable, and experience indicates the advisability of giving serious consideration to this precautionary measure.

In Great Britain, it has been the practice to lay mains in duplicate on either side of the road when old mains are replaced. This policy has more than justified the additional cost, as in several instances when one main has been fractured or broken, the duplicate main has permitted maintenance of service. All types of portable equipment for the opening and closing of valves have demonstrated their value many times over. Full provision for emergency disinfection of broken and repaired mains is essential for maintaining water supply.

One of the most astonishing facts of the present war is that, due to such provision and to widespread publicity, no water-borne disease has occurred following extensive breaks in the distribution systems.

Special emphasis has been laid on the importance of providing an emergency source of water supply for fire fighting purposes. This can be derived from any available sources, regardless of quality; even the sinking of wells has been suggested. The provision of standby pumping equipment, located at different points, is also recommended. Such units can be housed in camouflaged buildings, adjacent to, or in the vicinity of, existing pumping equipment.

Limitations of Civil Defense

It must be pointed out that in almost all cases in America, as in the war zone, distribution systems were constructed with no provision for protection against air attack. Because of this, of course, no guarantee can be given that a water supply will not fail as a result of intensive bombing. A consideration of the official data on the destructiveness of bombs leads to the conclusion that it would be necessary to locate a pipe at least 60, and more nearly 80 feet, below surface in clay soil to obtain protection against a 1,000-pound bomb. This means that protection against the largest bomb is beyond the ability of civilian or public authorities to obtain and construct.

Into this picture, of course, enters the element of chance. About 16 per cent of the area of an average city is covered by structures of one character or another. Of this 16 per cent, however, only a very small part overlies water supply structures or similar utilities structures. With reasonable defense against air attack, the bombing, therefore, becomes a random activity; and given this random bombing it is a matter of mathematical probability whether a water works station or main will be hit.

The absolute necessity of joint military and civilian defense as against civilian defense alone is clearly demonstrated in an experience reported from the war zone. In one city, which has had fairly effective protection against air attacks, breaks in the distribution system have occurred at the rate of 1 per 100 miles of main per day, over a period of several months. In another city, where the defense against air attacks was very inferior, there were attacks of such intensity, over a two-day period, that water mains were broken at the rate of 1 break per linear mile per day. On the one hand, it will be seen that the breaks in the water mains occurred at such rates as to be within the ability of a well-organized water department to repair; but, in the other, where the effective bombing was so intense, the restoration of service was impossible.

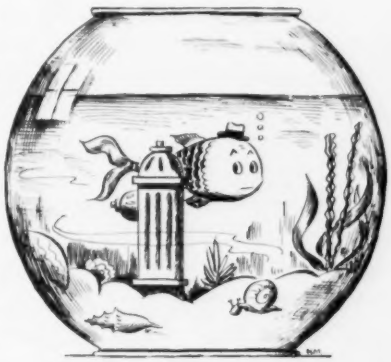
The two sets of figures represent the difference between reasonable and inadequate defense against air attack; and would seem to indicate most emphatically that civilian defense is only an adjunct to military activity. The military force of a country, in the form of aircraft or anti-aircraft guns, must be organized in sufficient strength to make it impossible for enemy aircraft to do more than random bombing under adverse conditions.

Unfortunately, due to war-time regulations, it is not possible to give details as to some of the actual damage to water supply systems. The value of preparedness, however, is well pointed out in the comment of a prominent British water works engineer, who recently said:

"The only criticism I have to make . . . in general, the whole A.R.P. report and control systems, worked out on paper with no chance of real rehearsal until the real night work under raining incendiaries, worked excellently; and I think that in all the raids we had, including the heavy . . . raids, things were gotten back to normal in remarkably short time. Sterilization of damaged mains by chlorine is routine practice now. After heavy raids it is a big job, for the risk of sewage contamination is greater than in any normal time. People are, of course, perfectly willing to put up with the slight chlorine taste on those days, when normally there would be the very devil of a shout. Strange things we humans . . . ".

Public Relations Begin at Home Or—A.B.V.R. Goldfish

By John C. Mellett



PUBLIC relations work is an art, rather than a science, and while it is just as exacting in this modern age as most of the so-called exact sciences, it cannot be said to be nearly exact, as to formula or method. I make this statement as an apology, not for my position as a student of public relations and a practitioner of the art, but for my effort here to make a scientific approach to the subject. This I shall undertake, without a slide rule, minus a T-square, and wholly lacking in microscopes and chemical solvents.

My motive in writing this paper is a desire to debunk, if possible, some of the many formidable, imposing, logical, careful *and* expensive public relations programs you have heard described at great length, and have seen undertaken at great pains and more disaster! Meetings have been held, committees have been appointed, procedures adopted, speeches made, almost without end,—and *still* we have public relations problems, hither and yon! Many of us shiver, and dodge instinctively, nowadays, when we hear the term, "public relations." So, in order to be helpful and restore a good name to its proper repute, I wish to do a little debunking.

My scientific approach to the question consists of an attempt to find a lowest common denominator, and I think I can discover it for

A paper presented on June 25, 1941, at the Toronto Convention by John C. Mellett, Public Relations Counsel, Public Service Co. of Indiana, Indianapolis, Ind. Cartoons by H. W. Montague.

you. Take the work "relations." It does not necessarily mean some cousins and their wives coming to spend Sunday when we'd planned to go fishing. But it does imply connections, connections of something with something else. In this case, it means *our* connections.

What Are We?

All right, who are *we*, in this great and essential water utility industry? Who *are* we? In my estimation, we are pretty nice folks. Some of us get a little tough, on occasion, especially in business hours; but, on the other hand, some of us are good-humoredly lax. Many of us had pretty good schooling, and some of the chemists even went through college. I know some good water operators who are active in churches and Sunday schools.

Some of our engineers and accountants get snagged with easy payment plans, and, in my own case, not to be personal at all, I frequently am taken in by a clever book salesman. Only a few of us buy tailor-made clothes. Some of our sons do not marry just the girls we would have picked out for them, but what saps our sons would be if they let *us* do their picking for them! Few of us beat our wives, but several of us get our own breakfasts! I know one superintendent who has a lot of trouble, always bailing out an old uncle who is forever getting tight.

Some of us are too lazy and trifling to exert ourselves in lodge work, but, on the other hand, some of our metermen are up around the top in two or perhaps three orders, while others are not members at all. Savings banks attract some of us, but *not* the fellow whose son is studying medicine, which is an eight-year course these days—he has very little to take to a savings bank. This boy never made an honor roll in his life, but *some* of our kids did!

There is no secret about these things. We all know who we are—just plain, common, average folks trying to get along. Isn't that true? And the only difference between us and anybody else is that *we* are in the water business, and they're not. In short, *AB, VR Goldfish*! Please, gentlemen, don't look around at your neighbors and mutter, *O, VNO Goldfish*! There is no denial that can stand.

VR Goldfish, in this business, in any public utility business, for we have absolutely no privacy. Can the chemist hide, with the quality of his water? No, everybody knows about it, everybody in

town! Can the accountant make a secret of the book he keeps? Not if anybody wishes to see—anybody expressing his wish through some official body. There can be nothing hidden about the rates, the earnings, the service; we hide the mains, of course, but wait—if there is anything wrong with them which taints or fouls the water *that* is public knowledge pretty quickly; or if there are serious leakages, *they* show up in the accountant's book and become public knowledge at least at the end of the year.

Like war bills, we are fraught with a public interest, to borrow a phrase from Woodrow Wilson, and, so, sound highbrow. But I like to put it simply this way, *AB, VR Goldfish*! And there's nothing of disparagement in the comparison. Has any of you ever seen a goldfish do an unkind, unfair, ugly act? I ask you! Have you seen a goldfish scowl? Seen one leave muddy tracks in a customer's kitchen? Heard one gossip with another while a customer waited? Not goldfish—they're well-behaved, nice folks.

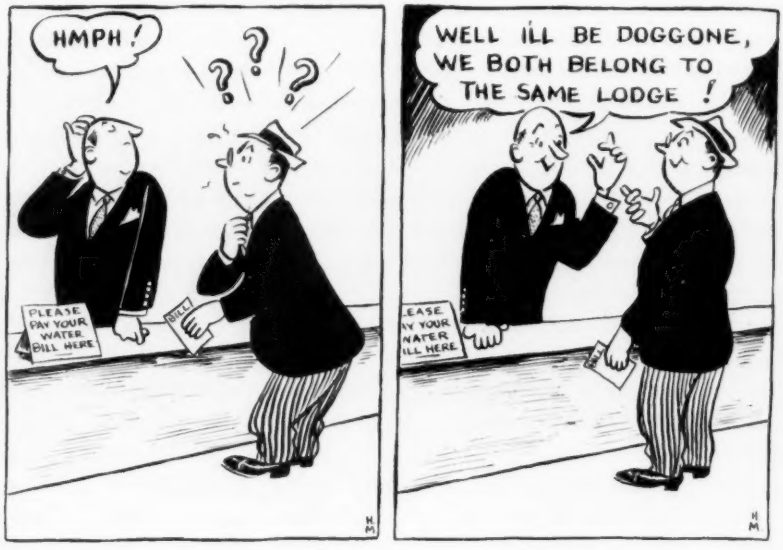
So, *VR Goldfish*. And my only suggestion, my whole entreaty, is that when we leave the house in the mornings to enter the bowl and swim about our affairs clearly in the public view, we should take our native good manners and our natural decent humor or disposition right along with us! Let's forget our office, or artificial, manners. Let's abandon the set smile or the fixed grim scowl. Let's forsake the old work hours temper, and be ourselves, fish or *Goldfish*. And this supplication, gentlemen, is to you *big* fish, as well as to all the little fishes, suckers or minnows down as far as meter readers, and beyond! Because little fishes imitate the bigger ones.

I make this appeal because public relations begin at home. That's where we live and operate. And if the relationship is to be good and pleasant and profitable, *our* end of it must be all right in every way. So much for us *Goldfish*, official and common, plain or fancy, large and small, married or single, tipping the barber or sneaking out guiltily—so much for us, as long as we remember that our best display is a public view of ourselves *being* ourselves naturally, humanly. And, as long as we remember that as we live our average lives, the privilege we have as water purveyors is the privilege, *not* of regulating or controlling *their* lives by our control over their vital need, but rather the privilege of co-operating with our customers so they can live their lives as comfortably as may be.

Are Customers People?

This is no longer a scientific *approach*, merely! I'm right in the middle of the problem, now, and must regard the other fraction—the customer.

Who and what *are* customers? That seems a simple, almost stupid question to ask about the other half of our problem in relativity, but I ask it in order to probe the answer. You will say: "Why, people of course!" But, having noted the manner in which customers are sometimes treated, I am tempted to paraphrase the old question we



Customers *are* people — even as you and I

used to hear back in suffragette days, "Are women people?" or as a writer in *Harpers* inquired recently, "Are stockholders people?" and ask, "*Are* customers people?"

A minority of cashiers, information clerks, service men, meter readers and, even, chemists, occasionally behave as if customers were *not* people, but some lower form of life. They forget that some customers have mortgages to carry, and payments to make on the car that was new last year. They should remember that customers have children to clothe. Their kids have measles. I know a customer, with a family of his own to provide for, who smokes a pipe instead of

cigars, which he much prefers, in order to lay by a little help for the children of his brother's widow. And the widow is a customer, herself.

And there are customers whose arches bother them, and customers who wish that dentists would work for nothing. A lot of them prefer safety razors; some even brag about their electric shaving! Some customers prefer Moon Mullins to Skippy, while others choose Wimpy and Popeye over both. Personally, I favor Wimpy. Many customers like the movies, especially westerns, and not a few revel in murder mysteries, a majority obtaining them from the rental or free libraries in preference to buying them. Have *you* read the latest *Perry Mason* thriller?

Some customers are bald-headed; others have a great deal of trouble with their digestions; a *few* go South in Winter, North in Summer; but most of them are glad to get in a little fishing during a two-weeks vacation in August, if, indeed, they travel at all. A small minority of customers enjoy and suffer at contract bridge and golf. I know one customer who can't putt for sour apples. Neither can I. Many customers are keen baseball fans who know, right up to last night, whether and how much Joe DiMaggio is hitting. These folks like peanuts. So do we.

This seems to be a great deal of talk to make my point, but I do wish to emphasize my own feeling that customers *are* people—people just like us—or maybe more so! True, they may put on a shell of defensive armor when they come in to pay a bill. But so do *we* don armor, too often, *far* too often, when we step into the office or the plant in the morning.

Let me give you just on example. We had a miscast engineer serving as a manager a few years ago. The position bothered him. He angered customers more often than not. He seemed to have a chip on his shoulder all the while. I could not understand his attitude, for outside office-hours he was mild-mannered and pleasant with everybody. One day I asked him: "Are you scared more of customers or your superiors?" "Why, of my superiors, of course," he replied. "I know who pays my salary!" You see? How mistaken he was! He thought his *employers* paid him!

This brings me to the point in all my talk about customers with chilblains and customers who never quite see how they'll raise the money for their next tax bill. My point is, that we, as superior officers in this business, should take steps to make sure our employees, from ditch diggers to cashiers, understand that customers are people like

themselves, to be *treated* as people. And that requires that *we*, ourselves, be convinced, always, that customers are people, like ourselves—people more likely to make themselves heard when aggrieved than when satisfied—again, if you please, just like ourselves. For, aren't we all!

100% Public Service

Accent on Service

Now, what is the link between us goldfish and our customers. The relationship depends on two simple little two-legged facts. We find ourselves with more prospects, probably, than anybody but undertakers have. (*Everyone* is an undertaker's prospect!) Almost everybody is our prospective customer. Why? Because people are thirsty, or fear to become thirsty; and people are dirty, soiled and subject to perspiration, *or* fear they will become so. Aren't they all? And finding themselves in this position, they turn to us. Digging their own wells is of course out of the question; and it is a nuisance to run with a bucket to a neighbor's well, a stream, or a lake. They turn to us, naturally, instinctively; they cannot shop around or get bids on their water needs. They need help in their struggle against thirst and dirt, so *they come to us goldfish*!

We can't help ourselves. We've just naturally *got* customers! And this is a very remarkable phenomenon in the modern world of business. All *we* need is readiness and willingness to serve; but what of the merchants around and about us? You may have heard that gem of verse which tells the story:

"Who goes and whispers down a well
About the goods he has to sell,
Won't reap as many golden dollars
As he who climbs a tree and *hollers!*"

There you have it: Other merchants must holler for customers.

They advertise, they compete, in price and courtesy and service, for customers. But what of us?

Our company, for instance, does about three-quarters of a million dollars a year in gross for water service. Do we spend $20,000 to $35,000 a year *advertising* to get and hold that business? We do not, nor do we have to so! But another merchant would, and be glad to get the gross on that basis. Or, let us take another example, in the publishing field. A daily newspaper comes close to being a public utility these days. A daily paper receives, we'll say, $5 a year for subscription. In the old days, that $5 just about covered the cost of serving the customer; but twenty years ago successful publishers matched that $5 with $5 of their own. And, nowadays, many of them spend $10 per customer, and some $15, in *addition* to the customer's $5, to get and hold him as a subscriber! But that's not we—we've *got* customers.

How can the publisher do it? Because other merchants of all types, and manufacturers, too, are buying pages and pages *and* pages of his advertising space, in *their* frantic and expensive efforts to obtain customers and keep them, once they're obtained! Others go to great lengths (even the undertaker advertises nowadays) and some actually go so far as to boast that, where *they* are concerned, the customer is always right. And I suppose you remember back in the heydays (the making hay days) of the 1920's, that bondhouses went so far as to employ and feature customer's *men*! There was the extreme, the limit! Special men, for the customers, as if other employees could not be bothered, or depended upon, to treat customers civilly!

But none of that, for us! We goldfish just naturally have customers, as long as people get thirsty or soiled! The thing is so simple, *so* inexpensive! It is almost automatic, effortless. And yet, here we are, a great necessary industry, taking time out to discuss our relationships with our customers!

If there is any need for this discussion, I submit that it must have arisen from out of our own forgetfulness. We must have forgotten that public relations begin at home. We must have forgotten, now and then, that we are goldfish with no privacy whatsoever, and must have done some little, discourteous, mean or grasping acts—acts that were better not done at all, or if done, better done in some furtive darkness, away from the public gaze.

We should remember, as we serve in the *open*, to serve *openly* the people, who are customers, it is true, but after all are merely folks, like ourselves. Customers are nothing in the world but friends and neighbors! They have just as much trouble with a used car as we do! And maybe more, with a no-parking sticker!

This simple line of thought has been helpful in our business at home. We ask our fellow goldfish to remember that the Company is known by the men it keeps, just the same as the men are known by the company *they* keep. Their actions reflect credit or discredit not merely upon themselves and the company, but upon each other!

Because, *AB, VR Goldfish*! For all the world to see.

EDITOR'S NOTE: *Supplies of reprints of this paper will be made available to water works superintendents. Please send requests to A.W.W.A. headquarters.*

Social Security Legislation and Retirement Planning Affecting Water Works Employees

By Dale L. Maffitt

THE need for a comprehensive nation-wide program of social security has received increasing recognition for a number of years. In August, 1935, this problem first became a matter of national legislation with the passage of the Social Security Act. This act provided for old age and survivors' insurance to be administered by the federal government, and offered to the states, federal co-operation in nine federal-state programs: unemployment insurance; aid to needy aged, needy blind, and dependent children; services for maternal and child health; child welfare; the treatment of crippled children; public health; and vocational rehabilitation.

The part of this legislation in which water works men, as an employed group, are interested is that which has to do with old age and survivors' insurance. In the original bill, which became effective January 1, 1937, more than 43,900,000 accounts were established for industrial and commercial workers, but these did not include the more than one million municipal employees of the nation. Specific exemptions to participation in benefits of the Act as listed under Section 210 (b) include: "services performed in the employ of states, a political subdivision thereof, or an instrumentality of one or more states or political subdivisions." This means that most water works employees receive no benefits from the legislation.

The original Social Security Act placed upon the Social Security Board the duty of studying social needs and legislation and the further duty of making recommendations for progressive development. As a result, in August, 1939, on the basis of administrative experience and study, a bill was passed by Congress amending the Social Security Act to make it more nearly meet the needs of the

A paper presented on June 25, 1941, at the Toronto Convention by Dale L. Maffitt, General Manager, Des Moines Water Works, Des Moines, Iowa.

people as a whole. The major changes made by this amendment were: provision for increased federal grants for public assistance and for health and welfare services; changes in the taxing provisions relating to old-age and survivors' insurance and unemployment compensation, which were designed to bring about substantial savings for employers and workers; and liberalization of the old-age insurance plan, established by the original law, to provide earlier and more adequate payment of benefits and to extend monthly benefits not only to the worker but also to his family, including supplementary benefits to aged wives and dependent children of retired workers, and monthly benefits to surviving widows, orphans and dependent parents.

In general the original Act covered all industrial and commercial employment in the United States. Under the amendment the principal new inclusions were employees of national banks, state banks which are members of the Federal Reserve System, and building and loan associations; employees on American vessels; and workers over the age of 65.

Plans for Extension of Social Security

Experience and research in the future will undoubtedly offer further suggestions for improvement in national legislation toward social security for the American people. It is in these future improvements that water works men should be concerned. Some plan whereby water works employees may be assured security in their old age should be evolved. Inclusion in the national program would seem at first glance to offer the ideal solution, but there are a number of problems involved which must be worked out before such legislation can become a reality.

Widespread discussion among public employees, of the proposed plan for extension of the old-age and survivors' insurance provisions of the Social Security Act to employees of states and political subdivisions thereof, has given rise to protests from participants in retirement systems now in operation in many communities. With this problem particularly in mind, the Municipal Finance Officers' Association arranged a conference with representatives of the Social Security Board and the Federal Security Agency. This conference was held in Washington, D. C. on November 25, 1940, to discuss informally the effects of extending the Social Security Act to public employees. An account of the material discussed is outlined in the publication, *Minnesota Municipalities*, for March 1941.

It was agreed that the objectives to be accomplished by the extension of federal insurance coverage to state and municipal employees were as follows:

Primarily: (1) To provide continuity of protection for those employees who transfer from one employment to another during their working lifetime. (2) To provide some sort of protection for approximately one and one-half million public employees not now covered by any retirement system. (3) To provide survivors' benefits for those having no such survivorship protection.

Secondarily: (4) To avoid any reduction in existing protection, such as old age or disability benefits, as provided by existing systems. (5) To prevent unnecessary duplication of protection in two or more systems and to adjust the differences between systems so that no individual will be without adequate protection.

Several possible plans for meeting these objectives were discussed. One, as proposed in the Wagner bill, would provide compulsory coverage for all state and municipal employees regardless of existing retirement systems. This would accomplish the three primary objectives. Objections to this plan were: the increased expense where retirement systems are now in existence; the possibility that such federal legislation would be unconstitutional; the delay entailed in state and local legislation necessary to legalize taxes and adjust existing systems; and administrative difficulties due to the constant change in state and local officials.

The second plan discussed was the Wagner bill amended. This would provide compulsory coverage for all state and municipal employees not now members of an existing system, and would accomplish only the second major objective. This plan might be unconstitutional and would be difficult to administer. In each of these plans, too, the political objection of forcing a federal insurance program on self-governing state and municipal units must be regarded.

The third plan discussed was that of voluntary agreements. This would extend coverage by voluntary agreements between the federal insurance system and states or minor political units. Here again there would be difficulties in administration and inequality of benefits.

It was evident in the discussion that there was considerable opposition to any plan of extension of the Social Security Act that would not permit the preservation and perpetuation of those systems already in existence. A committee was appointed to follow develop-

ments on this question and to attempt to work out a satisfactory plan which would bring about the extension of the Social Security Act on a basis acceptable to both covered and non-covered groups of public employees, as well as to the Social Security Board.

Studies on Extension Problems

This committee held a meeting in Chicago, on February 15 and 16, 1941, at which were also present D. C. Bronson, Assistant Actuary of the Social Security Board, and Benjamin Kendrick of the Bureau of Old Age and Survivors' Insurance. Quoting from the report of the committee, as stated in the special news letter of the Municipal Finance Officers' Association, March 16, 1941:

"The committee viewed the question of coverage for the public employees in its broadest sense, from the standpoint of both the covered and non-covered groups. It was particularly concerned with the effect of any such legislation on the states and local governmental units because of the problems that would arise from any plan of extension which did not allow sufficient time for: (1) the required budget adjustments to meet the additional costs; and (2) amendments to existing constitutions, statutes or charters.

"It also regarded with some apprehension the disturbing effects on personnel policies of local governments which any extreme departure and sudden change in the existing retirement provisions would bring about, because of the fact that retirement provisions of many communities have been formulated with a view to realization of certain definite personnel objectives.

"The members of the committee took cognizance of the possibility that any plan of extension of the Social Security Act which would create a parallel system of benefits and salary deductions, with resulting increases in costs, would be looked upon adversely by the local governmental authorities, and might prove decidedly injurious to the existing systems.

"The question of constitutionality was considered of great importance, and one that could not be disregarded in a study of the problem, and it was the opinion among the members of the committee that any plan of extension which involved that question should be avoided."

The committee reviewed the several methods of extension as proposed at the Washington conference and as developed during the discussions, and, in making its recommendations, was influenced by the following considerations:

1. "That the problem of the public employee in relation to coverage under the Social Security Act is in many respects different from that of the industrial worker.

2. "That appropriate retirement provisions should be made for all non-covered groups of public employees.

3. "That continuity of protection for those employees who transfer from one employment to another during their working lifetime, and the provision of survivors' benefits for those having no such survivorship protection, are desirable objectives.

4. "That the perpetuation of the existing systems must be definitely provided for in any plan of extension of the Social Security Act for the protection of the accrued rights and future benefits.

5. "That a federal plan alone, in its most complete form, would still fall short of meeting the requirements of certain occupations for retirement ages lower than the prescribed standard, and in dealing with special hazardous occupations as well as with economic conditions peculiar to the various localities.

6. "That by giving each local community the privilege of choice with respect to participation in the federal system, sufficient elasticity will have been provided so as to afford protection to the existing local plans and make it possible for non-covered groups to secure a minimum coverage and supplementation."

The committee recommended that: "If the Social Security Act is to be amended to include public employees under the Old Age and Survivors' Insurance provisions of the said Act, such inclusion be made voluntary on the part of the states and political subdivisions thereof; that this can best be accomplished through the medium of voluntary agreements or compacts between the states and the federal government, whereby the states would enact permissive legislation granting to their own employees and the employees of their political subdivisions the privilege of participating in the benefits and obligations of the Social Security Act, provided that each political subdivision be given the right through its appropriate legislative body to exercise its choice in participating in the agreement made by the state."

John J. Corson, Director of the Bureau of Old-Age and Survivors' Insurance of the Federal Social Security Board, in an article "Social Security and Municipal Employees" printed in *Minnesota Municipalities* for March, 1941, states the problems in much the same way. It is his conclusion, however, that the advantages to be gained for municipal employees in general extension of the federal system of

old-age and survivors' insurance to all public employees would greatly outweigh the disadvantages.

As advantages he points out that it would provide retirement incomes for that 50 per cent or more of municipal employees who now have no such protection. The survivors' insurance providing monthly benefits for children under 18, widows, and aged parents, would give the essential protection that not more than one municipal worker in ten now has. Under the federal system, the worker would have a continuity of security if he changed jobs—either changing to another branch of municipal service or going into private industry.

One problem to be solved is the question of constitutionality. Mr. Corson suggests that one way to determine this is for Congress to extend the coverage to state and municipal employees and, through a test case, have the courts decide whether or not it is constitutional.

Assuming that it would be constitutional, the first actual effect would be to force states and municipalities to make adjustments in existing retirement systems. This would require careful study and considerable work on the part of those concerned, but it is not an impossible barrier. A great number of private industrial concerns had established pension systems before the Social Security Act was passed. These organizations have adjusted their systems to provide supplementary benefits for employees and to assure them of no loss of benefits accrued up to the time of adjustment.

Then there is the big question of the additional burden to be placed upon the taxpayer to provide this retirement insurance for all state and municipal employees. Mr. Corson thinks that the cost would be less than 1 per cent of the total expenditures of these municipalities, and believes that, with adjustment of existing systems, the cost might be even less. There is still the question of administration That, however, is a problem that enters into any municipal enterprise.

In conclusion he points out "that benefits under the old-age and survivors' insurance system are not geared to provide luxury, but are designed merely to afford a basic minimum of security, a floor of protection. . . . This essential protection is important not only to . . . individuals, but also to the society which has assumed the obligation of caring for those persons who are without other means of support through relief and assistance."

In view of the possibility of amendment to the Federal Social Security Act to bring employees of state and local governments under

the provisions of the old-age and survivors' insurance title, it might be well to point out briefly what this insurance is.

Provisions of the Present Act

The tax is 1 per cent each upon employers and employees through 1942. From 1943 until 1946 the rate will be 2 per cent upon each; from 1946 to 1949, 2.5 per cent; and thereafter, 3 per cent. The employee's per cent of compensation is deducted by the employer and paid with the employer's share.

In order to qualify for monthly primary insurance benefits a worker must be 65 years of age or older, must be fully insured, and must have filed application for benefits. A worker is fully insured if he has a certain number of "quarters of coverage," depending on the length of time he has been in employment covered by the system. A "quarter of coverage" is a calendar quarter year in which the worker has received $50.00 or more in wages for covered employment. In general, a worker is "fully insured" when he has "quarters of coverage" equal to half the quarters elapsing after 1936 up to the quarter in which he reaches 65 years of age or dies. A minimum of six quarters of coverage is necessary. After a worker has 40 quarters of coverage he is "fully insured" for life, regardless of whether he is in covered employment thereafter.

The monthly benefit which a worker may receive on the basis of his or her own wages is called a "primary insurance benefit." The primary insurance benefit is computed by adding 40 per cent of the first $50.00 of the worker's average monthly wage, and 10 per cent of the amount by which his average monthly wage exceeds $50.00 but does not exceed $250.00. The total of these two amounts is increased by 1 per cent for each year in which the worker was paid wages of $200.00 or more for covered employment. For example, suppose a man has been receiving an average monthly wage of $100.00 since the beginning of 1937 and chooses to retire when he reaches the age of 65 in January, 1942. He would receive $26.25 a month—40 per cent of the first $50.00 of his average monthly wage, plus 10 per cent of the remaining $50.00, plus an additional 5 per cent for 5 years' employment; or $20.00 plus $5.00 plus $1.25, making a total of $26.25.

A wife who is 65 years of age receives one-half of the amount received by her husband, unless she has been in covered employment and qualifies on her own account, in which case she receives whichever is the larger amount. Widows and children are also provided for.

Group Insurance Legislation in Iowa

In line with the recognized need for security for workers in the utility fields, the Des Moines Water Works succeeded in getting a bill passed by the Iowa Legislature in its 1940–41 session. This bill authorizes boards of water works trustees of municipally owned water works in certain cities to procure group insurance for employees of such water works, to establish a plan and fund for such purpose, and to administer the same.

Under this authorization the Des Moines Water Works is in a position to establish a group insurance fund to be created from the following sources: contributions from employees who elect to participate in the plan, and contributions authorized by the board of water works trustees from the income from operation of such water works in amounts not to exceed the aggregate amounts assessed against and collected from employees who elect to participate in such plan. Contributions to this fund by the board of water works trustees and expenses incurred in administration of the plan shall be considered to be operating expenses of the water works system.

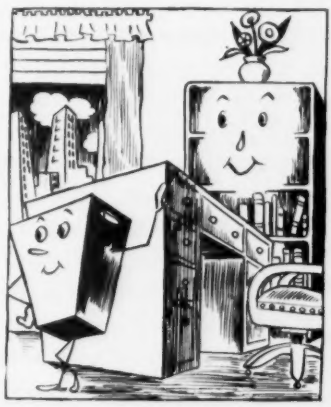
Participation in such group insurance is to be optional with all employees eligible to the benefits thereof as provided by the rules and regulations adopted by the board pursuant thereto. The board is authorized to contract with any legal reserve insurance company or companies authorized to do business in the state of Iowa for group insurance, which may include life, health, hospitalization and disability insurance, for its employees.

It is felt that this is a definite step forward in the effort to achieve social security for water works employees. The next goal is old-age insurance. If the provisions of the Federal Social Security Law should be broadened to include employees of municipalities it is probable that the states will have to approve the amendment to make it constitutional.

If the coverage of the Social Security Act is not extended to municipal employees, then independent plans must be organized. In either case, for the Des Moines Water Works in particular, it is believed that this group insurance authorization is the first approach to the final solution.

Critical Appraisal of Experimental Work

By John F. Norton



I HAVE recently acquired a new office. The furniture was selected and installed without consulting me. Indeed, I was vitally interested in only one article, knowing well that all the rest, as chosen by an expert, would be quite satisfactory. This one article was the waste basket. I did not want just an ordinary basket of cardboard or metal such as is commonly found in business offices, but one that would be a delight to the eye, would nestle in its surroundings in an unobtrusive manner while being of sufficient size and elegance to hold and attract the tremendous amount of material, worthy of perusal but which cannot be retained indefinitely in office files. Its subtle lines and proportions would be such that it could be regarded not only as a final resting place for communications from friends but, more important, as a depository for my own efforts, when they, having received mature consideration and self-criticism, have been tagged as unworthy, insufficient, or trivial.

When a piece of experimental work is finished and the data compiled with necessary comments and conclusions, the first consideration for its disposition should be given not to an harassed editor of a scientific or engineering magazine, but to the very attractive waste basket which yearns to hold, even for a brief time, the products of its office companion.

A paper presented on June 24, 1941, at the Toronto Convention by John F. Norton, Research Laboratories, The Upjohn Co., Kalamazoo, Mich. Cartoons by H. W. Montague.

This may seem harsh but as I glance at reprints of my own published articles during the past thirty years, I wonder, not why the various pieces of work were done, for they gave me pleasure and satisfaction at the time, but why they were ever submitted for publication. It is often difficult to decide what should and what should not be published. I have been asked to prepare a discussion which I hope will not be too trite and which may be of some benefit to the younger members of this Association. Let it be understood, however, that I do not pose as an authority on the subject.

Hans Zinsser has met the situation squarely in his statement, in *As I Remember Him*, that: "the conservatism of rigid criticism on the part of serious investigators is the only safeguard which stands between the public and charlatanry." While I am certainly not accusing any of my audience of the latter, the fact is that self-criticism is a basic concept in experimental work.

Professor Eliot Blackwelder, in an address before the Geological Society of America last December, said: "The critical testing of ideas, though a fundamental practice of the scientist, is a habit difficult for the average human being to adopt. An original idea is a brain-child and tends to be jealously cherished as such. To expose it to the cold light of reason takes a sort of Spartan courage that is too often undeveloped and yet is one of the essential attributes of anyone who aspires to be called a real scientist. To be merely logical with facts selected for a purpose is much easier than to divest oneself of bias. Steadfast courage and a renunciation of false pride are required in the search for opposing rather than supporting evidence."

In the same address, Professor Blackwelder also said: "the expert scientist is under great obligation to deserve the confidence of the public. His intellectual honesty will need to be outstanding and unwavering."

Research has been defined on many occasions and I shall not add another definition to the list. In a recent charming autobiography, *The Pilgrim's Way*, Lord Tweedsmuir has written: "Enterprises which make roads across pathless mountains, collect the waters over a hundred thousand miles to set the desert blossoming, build harbours on harbourless coasts, tame the elements to man's uses—these are the equivalent today of the great explorations and adventures of the past. So, too, the patient work of research laboratories, where to the student a new and startling truth may leap at any moment from the void. Those who achieve such things are

as much imaginative creators as any poet, as much conquerors as any king."

Thom, in his presidential address at the last meeting of the Society of American Bacteriologists, said that the research worker "may enter fields, hitherto unknown, as an explorer to discover what is there," or may "gather up the vast array of unfollowed leads, arrange, co-ordinate and complete tasks that other men have skimmed over, then left half done."

Most of us cannot be pioneers, for this requires a peculiar and rare type of intellect, but all can follow leads that others have indicated or that arise in observing the processes with which we are daily concerned.

Importance of Research Work

Research is worthwhile, call it experimental work or any other, perhaps less dignified, name. Plant operator or laboratory technician must indulge his curiosity or cease to be an asset to his organization. To be working on some problem, large or small, is a necessity not only for his development but to retain interest in daily routine. When a piece of research has reached a certain stage of development it is obviously desirable to collect the data in such a form that they can be critically reviewed and a decision reached concerning the possibility of publication. The experimental work, its method of presentation, and the conclusions must then be critically appraised.

Any problem is important to the person engaged in solving it. It is valuable for publication only if it has general application. Perhaps a slight exception should be made to this statement. Some condition peculiar to one water purification plant sometimes is sufficiently interesting to warrant publicity. But the criterion of general applicability is warranted. This can be stated in a different way.

Try to determine whether or not the experiments you propose to publish are of interest to others. Will the reader of the journal in which your article appears pass over its title or will he take time to study your material? This will depend partly upon the method of presentation, but the first measure will be interest.

If you are sure your problem is of general interest, criticize the accumulated data. Have you repeated your work a sufficient number of times to assure its correctness? I do not argue for unnecessary multiplicity of data, furthermore, I will admit that some classic reports have been made on the basis of a single experiment. Jenner's

first publication on vaccination against smallpox is an example, but this experiment was made after some years of observation and not as the result of a sudden inspiration. It is still true that a single, decisive experiment may be worth publication. The tendency today, however, is toward making a multiplicity of observations in order to satisfy statistical analysts. Criticism from such sources must be met, but at the same time experimental data can be reduced to reasonable limits for publication.

Experimental work originates because something has gone wrong with a system for which you have responsibility; because you may be interested in the mechanics or chemistry or biology of a process; or because you may have some original idea for improvement of a process or of methods of control. In any event you start with a definite theory and then attempt to prove that your intellect is functioning—perchance at capacity. Keep your mind open. Perhaps your hunch, which you have dignified into a theory, is wrong, and your data actually have proved just the reverse of your intentions. Perhaps your data should be used to develop an entirely new concept. It requires merely an agile, not a critical, mind to compile data to prove a theory. It requires intellectual honesty to follow those data to the proper conclusions.

It frequently happens that some experimental results will be out of line with the majority. While discarding such results may lead to more uniform tables or more perfect graphs, they should not be set aside without definite proof of their erroneous nature. This is so fundamental in all statistical analysis that it is hardly worth bringing to your attention and certainly does not need further discussion. *But it is still done.*

Preparation of the Research Report

The methods of presenting laboratory or engineering data often constitute a real problem, sometimes the major problem, in preparing a manuscript for publication. Tables and charts or graphs are, of course, used. These may be a delight to a reader and even to an editor, but they are just as likely to be a source of confusion to the former and of dismay or worse to the latter. Most of us have sat through (I almost said listened to, but we do not) the reading of papers illustrated by ubiquitous lantern slides displaying tables containing literally several hundred numerals, intended to show how much work the author has accomplished and how important his work is to humanity. Editors have been known to refuse manuscripts

because of the expense of setting many and complicated tabulations. Perhaps such editors have deprived the world of knowledge which might change the whole aspect of scientific thought or the social economics of a nation. At least the author of the rejected article thinks just that. Admitting there are times when the use of rather complicated tables or graphs is justified, in general it is far more effective to tabulate summaries rather than individual experiments and to use simple graphs or charts.

Regard your listener or reader as an inferior being, who may be reasonably well acquainted with his own field but who cannot possibly have the intellectual capacity to understand yours unless it is presented only in its simplest form. Write *down* to your audience. I want to emphasize this particularly because I have seen so much good work almost ruined in its presentation by complex tables that would have been more readily comprehended if titles alone had been thrown on the screen and the figures omitted. The man who insists on the publication of every figure which he has recorded in his private notebook has an exaggerated idea of his own importance and does not get his material published.

English composition is important. Unfortunately, education of scientists or engineers does not often give them facility in writing. This is less the fault of the educator than of the student. The latter has an urge to absorb technical material and is inclined to regard instruction in language as that part of his curriculum which can be slighted in favor of what he regards as his professional attainments. I have often been asked how to learn to write scientific papers. The answer is to study the papers of our best scientific writers and use them as patterns. A well-written article is easy to spot. It is couched in simple, direct, and correct English and leaves the reader with a feeling of satisfaction. Aids to correct writing are numerous and are supplied by publishers and editors.

Be sure the work is reported in such a way that it can be repeated by others. It is disturbing to find inadequate directions or protocols, but it is just as disturbing to read excessive details. It is admittedly often difficult to attain this happy phraseology, desired by other workers as well as by editors, with unnecessary detail omitted and essentials included.

One word concerning the use of scientific terms, particularly the species names of plants and animals. Use the recognized standard forms however much you may disagree with the nomenclature involved. This will give the reader a chance to identify the organism

mentioned, instead of indulging in a guessing game sometimes leading to the wrong answer.

The following criteria are suggested for those who have carried a piece of experimental work to the point where it should be appraised with a view to publication:

1. The research must be of general interest in its field.
2. The experimental work must be of unquestionable accuracy and originality.
3. The experimental data must be compiled and conclusions drawn with meticulous intellectual honesty.
4. All pertinent results whether or not they are in accord must be included.
5. Tables, graphs, and charts must be prepared in as clear and as brief a manner as is consistent with adequate presentation of data.
6. Simple, direct, and correct English must be used.
7. Adequate directions and descriptions must be included and unnecessary details omitted.
8. Recognized scientific terms must be used.
9. Be your own severest critic but welcome also the criticism of others.

Finally, I shall attempt to follow my own advice and, on returning to my office, will place this manuscript reverently in my waste basket where may it rest in peace.

EDITOR'S NOTE: This office considers Dr. Norton's paper to be definitely *bookcase* not *waste basket* material. Those proposing to record the results of research should study his remarks with care.

Experiences With Cathodic Protection of Water Tanks

By J. Clark Keith

IN THE JOURNAL for the years 1929 through 1934, the word "cathodic" does not appear in the index, either of the test material or of the abstracts. In 1935, in a paper by K. H. Logan of the National Bureau of Standards (1) the following reference is made:

"Cathodic protection as a method of preventing the corrosion of pipe lines was suggested by Clement and Walker in a publication of the United States Bureau of Mines in 1913, but little use was made of this method of protection until it was tried on a gas transmission line by the New Orleans Public Service Inc. in 1930. Since then it has been tried out on several other pipe lines and all users appear well satisfied with the results. The essential feature of the method is the maintenance of the pipe negative or cathodic with respect to the earth, by means of a superimposed current usually furnished by rectifiers such as are used for charging storage batteries. In order that the current consumed shall not make the cost of operation excessive, the line must be protected by a nearly perfect insulating coating such as a reinforced bituminous coating and be free from metallic contacts with uninsulated lines. Such a system was well described by papers presented at the 1933 Convention of the American Petroleum Institute by R. J. Kuhn and by Starr Thayer."

In 1936, although no text material on the subject appeared there were six references among the abstracts, in one of which the following quotation appears:

"Pipe coatings are perhaps the most important protective measure. Electrical drainage methods sometimes give good results but care must be taken in their insulation and they must be continuously supervised while in use."

A paper presented on June 24, 1941, at the Toronto Convention by J. Clark Keith, General Manager, Windsor Utilities Commission, Windsor, Ont.

In 1937, at the Buffalo Convention, Russell E. Barnard of the American Rolling Mills Co. made the following reference to cathodic protection (2):

"No consideration of methods of protecting metal pipe lines underground is complete without mention of the successful and ever-growing method of cathodic protection. This name is taken from the nature of the process which consists of making the pipe line a continuous electrical conductor negative to galvanic currents in soil through which it passes. The result is economically achieved by impressing sufficient direct current voltage on the ground outside pipe to prevent natural galvanic currents escaping from pipe wall to soil. It need only be mentioned here that to economically cathodically protect any given pipe line, it should be electrically continuous and coated with enamel of low electrical conductance, shielded against soil stress by suitable non-moisture absorbing wrapping. If cathodic protection is used, then well-coated pipe renders indefinitely long service. The fact that cathodic protection is successful indicates that the currently held electro-chemical theory of corrosion is basically sound."

Abstract references to the subject appear to be completely lacking in 1937. Four papers and three abstracts were published in 1938.

All references to cathodic protection up to this date dealt with pipe lines or structures other than water tanks. The utilization of this principle in the protection of steel tanks had not yet been publicized in the JOURNAL.

In 1939 a single paper (3), dealing with Australian practice, and five notations among the abstracts, were presented. Among the latter is the first reference to tank protection to be found in the JOURNAL. This was the summary of a paper (4) submitted to the Ohio Conference on Water Purification regarding a 200,000-gallon tank at Clairsville, Ohio.

One of the abstracts (5) deals rather tersely with methods of protection which have met with a greater or less measure of success and which have had general use:

"Waterproof painting offers inadequate protection; bonding insulating material to pipe gives trouble; enamel chips; grease coatings do not stand up; cathodic protection in connection with suitable coatings seems most effective."

At the annual convention at Atlantic City, there was a round-table discussion led by W. W. Morehouse, Superintendent of the

Dayton, Ohio, Water Department on the "Application of Cathodic Protection to Water Towers and Tanks." Two papers dealing with this topic were presented at sectional meetings in Michigan and Montana.

In 1940 two published papers (6, 7) dealt with the application of the cathodic principle to the protection of steel tanks and these appear to be the first presentations on this subject published in the JOURNAL. Five abstracts during the year referred to protection of pipe lines or other material. A growing interest in this subject may be discerned in the submission of papers dealing with this topic at eight sectional meetings during the year.

In the JOURNAL for 1941, so far, three papers (8, 9, 10) and 15 abstracts refer to cathodic protection. The operating experiences outlined in some of the 1941 publications are pertinent to the subject of this paper although they do not refer directly to water tanks. From the publications of the Technical Section, American Gas Association, the following statement is derived:

"Effect of cathodic protection not entirely determined as yet; H formed may be expected to increase bacterial growths. On the other hand growth may be prevented by raising of pH beyond growth point."

The following quotation is from the abstract of a paper by Donald H. Bond, in 1940 (11):

"Forty-five 55,000-barrel tanks have been successfully protected from corrosion by cathodic protection from four 15-volt, 100-ampere generators during three-year test. All tank bottoms and connecting pipe lines had average negative potential of 0.8 volt or more. Metal to ground potentials on outside angle iron of tank should average approximately 0.05 volt greater negative than accepted potential valve for complete protection in order to ensure full protection at center of tank bottoms."

In a report presented to the American Railway Engineering Association by the Committee of Water Service, Fire Protection and Sanitation (12), one part dealt specifically with "Cathodic Protection for Prevention of Corrosion of Steel Tanks," developed in collaboration with the Electrical Section of the Engineering Division of the American Association of Railroads. The following quotations are from this sectional report:

"Approximately 6,000 steel water tanks are now in railroad service representing a capital investment of $30,000,000. The expected life

of these facilities should be about 60 years. However, due to underwater corrosion, this is being materially reduced by the loss of steel. Based on actual tests, the coating of the interior surface of steel tanks with paints of various types affords protection for a period ranging from 1 to 4 years. The labor cost involved in scraping and cleaning the interior of steel tanks averages 2.4 cents per square foot; application of paint, 1.9 cents; painting material for two coats, 0.7 cents; or a total of 5 cents. At this rate the painting cost for the interior of a 50,000 gallon steel tank will be approximately $95.00, while larger tanks 40 feet in diameter by 74 feet high, $790.00, with removal of tank from service for a period of four to fifteen days which is the more important item. . .

"In observation of tank interiors that have had this type of protection, it is noted that the old scale and rust is gradually sloughing off, the metal becoming coated with a gray deposit. The protection, however, is due to the microscopic hydrogen film instead of the gray deposit. . . .

"At the present time (December, 1940) about 25 installations of this type are in service on American railroads, the oldest unit having been installed in March, 1939. The cost of the units installed depends on the area to be protected. A unit with one or two electrodes for a 50,000-gallon elevated tank with an inside area of approximately 1,800 square feet will cost approximately $250 plus the expense of running power to the tank. The power cost of operating the cathodic protection unit ranges from 50 cents per month up, depending on capacity of installation. . . .

"With cathodic installations it is still necessary to paint the underside of the roof and the tank shell above the water line as protection does not extend to the surface area of tank above the water level. . . .

"Cathodic protection of steel water tanks against the corrosion action of water is still in the experimental stages; however, the indications are that some benefits are being obtained. Because of the limited period of operation in railroad water service, more time will be required to demonstrate whether cathodic protection is the satisfactory method to prevent corrosion in steel water tanks."

A review of many articles on the subject of cathodic protection discloses a fair consensus of opinion on the causes but there seems to have been a failure to give sufficient thought to ascertain what this electrical preventive method really is. The key to a proper consideration of electrical methods lies in an innocuous sentence in Dr. Speller's

book (13): "The effect of electric current from a super-imposed voltage should not be confused with localized corrosion."

Extension in Use of Cathodic Protection

The use of this electrical method on water tanks has been going through a period of development similar to that which most industries experience in their first years of existence. It would appear that its first application to water tanks occurred in 1936.

In the beginning, many of the applications were more or less crude but constant improvement has been made in five years which have elapsed since that time. In discussing the intimate details with persons who have had experience with the application of the system, it would appear that the science has been well formulated as a result of experience. It has been definitely determined that to keep a steel water tank from rusting, a potential must be applied from an external source which is in excess of the natural hydrogen overvoltage potential of the metal. An active surface of steel is said to have a positive potential of less than 2 volts. To overcome this it is desirable to effect negative potential of 2 volts or more at the surface of the tank and the voltage drop across the water must be estimated so that the proper e.m.f. can be supplied at the source. It has been found necessary to maintain a current flow at 3 amp. for every 10,000 sq.ft. of submerged surface of metal if it is to be protected.

The following information, as to the extent of cathodic installations at the present time, has been provided by two installing companies:

COMPANY	INSTALLATIONS				TO DATE
	1938	1939	1940	1941	
A	35	100	175	175 +	485 +
B	41	84	192	200	517
Totals	76	184	367	375 +	1,002 +

The figures for this year represent orders rather than installations, but the actual number of tanks now provided with this protective device would appear to be approximately 800. A third company which specializes on protection for boilers, condensers, hot water heaters and exchange units generally, did not submit any data.

Anodes

The operating experiences of companies which provide equipment are dissimilar. One expresses a preference for a special type steel for anodes as compared with graphite or carbon, while another points out: "The disintegration of one pound of graphite would require 4,053.26 ampere-hours as compared with 790.11 for stainless steel. (These figures indicate that the probable effective life for carbon is over five times as great as stainless steel.)" A third organization advises: "We have found through much experience that there is no better material than pure low-carbon steel, free from impurities." One company has changed progressively from mild to stainless steel then to carbon and finally to cylindrical containers of varying diameter and length made from spun glass cloth filled with coke breeze. This type of cloth apparently resists disintegration and there is little if any loss in carbon.

Ice Problem

The ice problem is perhaps the most difficult of all factors to provide for in installations of cathodic protection systems in northern areas. In reply to an inquiry sent to the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., the company sent a questionnaire to owners of all tanks built by them within the last six years. The replies showed that approximately 8.7 per cent of those tanks are now or have been equipped with cathodic protection, and that the owners indicate that it is entirely satisfactory in 73 per cent of the tanks, is unsatisfactory in 13 per cent and is questionable in 14 per cent of the installations. The most common reason given for the dissatisfaction is the interference with the electrodes from ice in the tanks during the winter season.

The opinions of three manufacturers concerning the possibility of solving this difficulty are given below.

1. "There has been a great deal of discussion in regard to the problem of ice in the northern territories. We have done a lot of research work in this connection and tried various methods such as heaters, agitators, etc. The cost of applying such remedies is almost prohibitive. Out of the several hundred installations which we have made, we have had possibly not over 35 to 40 cases where the ice problem entered during our entire experience.

"We find that with well water where the water comes into the tank at a temperature of about 55 degrees, there is little danger of freezing, especially if a fair quantity, which keeps the tank fluctuating part of the time, is used. In cases of surface water, the ice condition is more serious. It does no serious damage, with the exception of the breaking down of the electrodes, which, of course, can be replaced at no great expense.

"Various types of electrodes, such as graphite, stainless steel and other metals, may be used. With the steel electrode we find the ice will not freeze tightly to the electrode because of the current passing through the electrode. Even though small, it seems sufficient to be of great benefit in this connection.

"Our biggest problem regarding ice has been where the water was permitted to drop below our electrodes. The ice would slip down the electrodes, but after slipping off the bottom of the electrode when the tank is being refilled, the ice then pushes up under our electrode causing it to bend. In such cases all that is necessary is to remove the electrode to straighten it out, and replace it."

2. "One of the greatest difficulties encountered by users in the northern states and in Canada is the danger of ice formation and its destructive action. There has been evidence of its effect in tearing out ladders and removing roofs from metal tanks. Naturally, no type of electrode, regardless of what it is made, could possibly be expected to withstand this type of action, and the experience of most officials who have had to contend with ice formation tends to substantiate this fact. During the past two years out of some 500 to 700 applications, approximately 90 have been equipped with externally applied electrodes which provide a current flow of 3 amperes per 10,000 square feet of underwater surface. Those who have been contacted seem quite satisfied with this type of installation. Improvements are being made a matter of research and there seems to be some reasonable assurance that an answer to the ice problem is in the immediate offing. Regardless of the type of electrode used, if it suspended in water, ice formation will tear it out in severe weather."

3. "Coming to the problem of ice, we have found that the usual method of suspending anodes from the roof or from some overhead construction is not dependable or practical. Naturally this has been the practice because it was cheapest and simplest to install and be-

cause perhaps no other construction was known. Having developed a mechanically strong method of attaching anodes to the sides of tanks under water and successfully insulating and wiring them through patented devices, we offer what we believe and guarantee to be a safe installation against ice conditions. The problem of overcoming the difficult matter of making a lasting connection of wire to anodes under water is met by means of our making these connections on the outside of the tank. In the use of this kind of construction, we can guarantee that ice on top of a tank will not damage the equipment."

Practical Experiences With Ice

From among many replies on operating conditions which have reached the author as a result of direct inquiry during the 1940–41 winter season, some excerpts may be of interest. For obvious reasons the source of the information is withheld, although in no instance was there a suggestion that it be considered as confidential information. None of these replies has been received from any company which is interested in the supply or installation of cathodic protection equipment:

Large Municipal Water Supply

"I feel free to state that the benefits and advantages of the cathodic protection system for the interior of our tanks have far outweighed any operating difficulties that we have experienced so far.

"Ice conditions in . . . are not severe in our elevated tanks but are bad enough in some winters to cause operating difficulties with cathodic protection electrodes. We first tried suspensions for these rods, which would break under the load of a reasonable amount of ice, letting the rods drop to the bottom of the tank where they would be recovered by a retrieving cable or rope which had been attached to them. Before this system had an opportunity to demonstrate its worth, we had an unlooked-for experience. Ice formed on the electrode when the water in the tank was low. When the tank filled, this cake of ice floated up with the electrode and bent it against one of the roof members of the tank. It was necessary to take this electrode out and straighten it before placing it back in service. On a second tank, electric heating elements were built into the upper portion of the electrode. There has not been sufficient ice formation in this tank yet to demonstrate the worth of this installation but we

suspect that the heating element would not extend its effect far enough down the electrode to care for the situation in severe weather.

"We are considering the possibility of removing the electrodes from the water during 60 to 90 days of the coldest part of the winter. Corrosion on the interior of the tanks is slow enough so that the possible harmful effect during two or three months without cathodic protection would be negligible. A 150,000-gallon wash water tank at our . . . Plant is being equipped with electrodes that may be pulled up out of the water from the roof hatch."

Railway Installation

"We have eight of these installations in service on . . . Railway and would be very glad to extend them to the rest of the 166 steel tanks which we have, if we felt sure that it would do all that is claimed. Four of the installations were made in March, 1939, and the balance in September, 1939. They have gone through only one full winter and we had trouble at two points with ice breaking the connection to the electrodes. This winter we have had the electrodes removed from the tank and placed on spider rods as soon as ice began to form, in order to prevent damage of this kind. It was felt that this was safe, as pitting is due to chemical reaction which would not be progressive in below-freezing temperatures. We expect to put the electrodes back in the tanks after the period of ice troubles has passed."

Municipal Supply of a Large City

"We have one 150,000-gallon tank so protected. This installation has been in use less than a year and has apparently given satisfactory results. An inspection will be made this spring and we will be glad to send you pertinent information obtained from the inspection."

Privately Owned Municipal Installation

"The cathodic protecting device has been in our one million gallon standpipe for several years now and no trouble of *any* nature has been experienced.

"The late winter of 1940 was unseasonably cold with below-zero temperatures for several weeks, but no injury resulted to the electrodes.

"During the winter months, we have relatively no peak daily demands, and the elevation of water in this standpipe can be allowed to operate between extensive limits without affecting service seriously. During the cold weather, with this type of demand, we are able to get a 33 per cent daily turnover in this tank. The water going in is at about 58°F. and keeps the water in the tank sufficiently warm to prevent freezing to the point of possible injury to the electrodes."

Small Municipally Owned System

"Our system has now passed through two winters and we have not had a particle of trouble from ice. Our water supply is from wells with a temperature of 53° the year around. The height of water in the elevated tank fluctuates sufficiently during each day to prevent serious ice condition even during severe cold. So as far as we are concerned, we can honestly say we have no ice problems here.

"Our system is working satisfactorily and our tank is in better shape from a pitting and rusting standpoint than it has ever been and we have not had any ice condition to contend with so far. So, that is all I can report to you at this time."

City Water Supply

"About the only matter of real interest brought up during the discussion at Kansas City [Convention] was that of keeping the cathodic corrosion control system in operation during the winter months.

"In fact, this is still a problem and we were obliged to take our own systems out of service during this past winter. The company keeps assuring us that they 'have whipped the problem,' but when winter comes they do not seem to have whipped it."

Large City Supply

"We here in . . . have had no experience with 'cathodic protection' of water tanks. We have several steel structures of the type that would lend themselves very readily to this type of protection. We have not made use of 'cathodic protection' due to the fact that we have considerable trouble with ice in these structures during the winter time. While I understand that 'cathodic protection' has been developed to a point where it can be installed where ice is a problem, to date we have not installed such protective equipment."

Municipal Supply for About 7,000 Population

"Our experience has not been satisfactory, particularily regarding service from the manufacturers.

"The outfit consists of a stainless steel electrode 18 feet long by $1\frac{1}{8}$ inches in diameter, suspended from the roof of the tank, connected to a rectifier situated in the base of the tank, delivering 24 volts d.c. at $\frac{3}{4}$ ampere.

"This outfit was installed in a 208,000-gallon elevated steel tank, 150 feet high, in the month of November, 1939. About the middle of January, 1940, the steel cable from which the electrode was suspended broke, on account of ice collecting on the electrode, although the manufacturers installed two electric heaters around the electrode, which were expected to keep it free from ice. Fortunately we discovered the broken cable before the electrode dropped to the bottom of the six foot riser pipe, a distance of 150 feet. We removed the electrode out of a six-inch film of floating ice and took it out of the tank. Failing to receive any satisfaction from the manufacturers, we replaced the electrode in the tank in the month of May, and put the outfit into service again. The device apparently operated satisfactorily during the summer months.

"We received no service until the month of November, when their representative came and replaced the rectifier with one delivering 12 volts at 5 amperes.

"On examination, in January, when we removed the electrode, the walls of the tank showed no sign of rusting and were apparently, in the same condition as when put in service in November, 1939."

Railroad Installation

"We made two installations of this method in April, 1940, in the central part of . . . State on the Main Line, both of which are in 100,000-gallon steel elevated storage tanks. In each of these places, any kind of paint on the inside of the tanks did not last very long. There seemed to be some property of the water which caused corrosion and the destruction of paint more rapidly than under average conditions.

"While these cathodic systems have not been in service much over a year, I am pleased to state that the protection has been complete during that time and I see no reason why it should not continue so.

"The cost of operation, as such, is almost nothing as the amount of electric current used is very, very small and the only expense outside of that is for maintenance. In the short time that we have had these installations the maintenance had not amounted to very much. We find the cost of installations, in our case, at least, is less than the cost of cleaning and painting, on one occasion, only the inside of the tank, and if you rely on paint for protection, we know the tanks must be treated every few years; and in the case of the tanks that I refer to, the paint did not last over a year, so that this method if it continues to protect is certainly much less expensive than painting.

"In cold climates where ice forms on the surface of the water, the insulated electrodes will be dislodged and we found it necessary to discontinue the operations during the cold weather. I do not believe that any corrosion has taken place during that period of interruption as there has been a layer of ice along the sides of the steel tanks; and, surely, with the exclusion of oxygen behind the ice, corrosion could not take place anyway and we have no evidence that corrosion did take place during the period of interruption last winter."

Cost of Operation

Costs of operation, as reported for several different installations, are as follows:

1. For a standpipe, 75 ft. high and 50 ft. in diameter, cost averages 80 cents per month, at 4.5 cents per kilowatt hour.

2. For a 50,000-gallon tank cost is 98 cents per month at 2.85 cents per kilowatt hour (minimum monthly bill $1 less 10 per cent discount). This compares with $85 as the cost of biennial painting and the additional cost of maintaining pressure over a 24-hour period for five days when the tank is out of service, estimated also at $85.

3. For a 750,000-gallon tank cost is $14.75 per annum at 3.6 cents per kilowatt hour.

4. For a 350,000-gallon tank cost is $15.58 per annum at 3.6 cents per kilowatt hour.

5. For a 250,000-gallon tank cost of current is 75 cents per month.

6. For a large supply equipped with cathodic protection it is reported that:

"In no case do we have a separate meter for these installations and the current used is recorded on the meter for general service at the particular location. Judging from the voltmeter and ammeter read-

ings, in no case should any of our eight installations exceed current consumption required to operate a 40-watt light continuously. We are not interested in whether the cost is $1.50 or $3.00 per month but we are definitely interested in the protection of the interior of our tanks.

"In all cases where we have made installations, the primary reason was the serious handicap and interruption to service which would result if the tank was taken out of commission for several days to be cleaned and painted. This part of the saving is difficult to convert to a dollar and cents basis. Our experience with 146 tanks from 50,000 to 1,000,000 gallons capacity indicates that the cleaning and painting expense will vary from $200 to $1,000 per tank depending on the size and condition. Our experience with paints indicates that even the best paint in the average water cannot be depended upon for good protection over a period of four years' time. It is my opinion that if cathodic protection be made to work, which our experience indicates that it can if properly installed and operated, it is well worth the installation and operating expense."

Conclusion

It would appear that the cost of current for such installations is not a factor where costs are being considered. There appears to be fairly complete agreement where systems are in operation that they render substantial protection against corrosion. All water works equipment is constantly improving and it is reasonable to suppose that like results will attend the efforts of the manufacturer in this field to solve those problems which he now faces.

Since there are frequent applications where it is impossible to suspend anodes in the electrolyte, it is necessary to develop the process so that the equivalent of these anodes can be electrically applied to metallic containers.

The use of element anodes as substitute electrodes would be for the purpose of applying a load to complete the circuit and cause a current flow. These element anodes could be placed on the installed container at any point or could be grounded on connecting water pipes or directly to a ground rod of any nature whereby the current flow should ultimately return through the metallic container.

One hesitates to forecast what the trend will be in this field of water works practice, but there is reasonable justification for the belief

that the following refinements will soon be a part of future installations:

1. New electrical circuits for this type of protection, which will be superior to anything now in use, will be introduced.

2. New types of electrodes, which will be relatively indestructible, will be developed for immersing in water as the anode of these circuits.

The externally applied electrode will be so improved that it can be used on tanks where it would otherwise be impossible to use electrical protection because of inaccessibility to tank interiors.

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Water Supply Defense in New Jersey

By H. T. Critchlow

THE State of New Jersey ranks sixth in the output of its industries. Another measure of its importance from a business and industrial standpoint is the fact that $1,388,000,000 in contracts on national defense, more than in any other state, have been placed in New Jersey. A large part of these contracts is for ship building and for the aviation industry. A complicated network of transportation lines traverses the state; and railroads and highways serving the metropolitan areas of New Jersey as well as New York City and New England are being taxed to capacity. The population of New Jersey in 1940 was 4,160,165, or 554 per sq.mi., making it the second most densely populated state.

The increased activity in the state emphasizes the importance of having utilities geared to meet the demands of population, business and industry in the metropolitan areas. Water supply ranks with transportation and power among the most important utilities. It is vital to the well-being, prosperity and defense of the nation that water supplies be adequate to meet the demands of population, industry and commerce. The protection of the water works properties against damage from any cause must be assured insofar as humanly possible. Serious interruption in water service would cripple industry, jeopardize health and create fire hazards not pleasant to contemplate.

Of New Jersey's population, 98 per cent is supplied by 273 water supply systems. Half of these are publicly owned and half privately owned. Total consumption is 390 m.g.d., or about 100 g.p.d. per capita. The northern metropolitan district, comprising the counties of Bergen, Essex, Hudson, Middlesex, Passaic, Union and

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a small part of Somerset, has a population of about 2,800,000 and is supplied by 33 water system of which 23 are publicly and 10 privately owned. Total consumption in 1940 was 272 m.g.d.

The southern metropolitan district, comprising Mercer and the northwestern portions of Burlington, Camden and Gloucester Counties, has a population of 525,000 and is supplied by 60 water systems of which 28 are publicly and 32 privately owned. Total consumption in 1940 was 54 m.g.d. The seashore resort district, extending from Sandy Hook to Cape May, has a permanent population of 275,000 and is supplied by 55 water systems of which 39 are publicly and 16 privately owned. Total consumption in 1940 was 33 m.g.d. Maximum consumption is 58 m.g.d. in the summer months.

New Jersey Defense Council

In September 1939, at the outbreak of the present European war, Governor A. Harry Moore created the Governor's Emergency Committee to assist him in formulating plans for safeguarding the interests of the State of New Jersey. This committee was composed of the heads of various departments and agencies of the state government. A considerable amount of constructive work was done by the Committee before its reorganization in 1940.

The National Defense Council, which was formed subsequent to the Governor's Emergency Committee, suggested that a permanent organization be set up in each state to act during the continuation of the national emergency. In October, 1940, Governor Moore, by executive order, constituted the Governor's Emergency Committee as the New Jersey Defense Council and instructed it to formulate a municipal plan of defense for the purpose of securing co-ordinated efforts in the interests of national defense. On December 21, 1940, the Legislature gave sanction to the Council, composed of 23 state officers and not to exceed 10 citizens of the state appointed by the Governor. Originally the Council was principally advisory and co-ordinating in its powers. On June 3, 1941, however, the Legislature enlarged its powers, giving it certain administrative authority, subject to the approval of the Governor.

On April 14, 1941, the Legislature enacted a law providing for the creation of local defense councils to be appointed by each mayor. The local defense councils advise the municipalities on defense problems; also advise and co-operate with the New Jersey Defense

Council. To date, 280 such local defense councils have been appointed. A law, enacted on June 3, 1941, gives the Council power to appoint local defense councils in the event that a mayor fails to do so within 30 days, or by July 1, 1941; so by that date all of the 566 municipalities of the state will have local defense councils or be represented on a joint council with its neighboring municipalities.

The New Jersey Defense Council carries on its work through sub-committees, the chairmen of which are members of the Council and the members of which are appointed by the Governor. These various sub-committees are as follows:

1. Consumer's Interest
2. Housing Works and Facilities
3. Military Operations
4. Human Resources
5. Agricultural Resources and Production
6. Health, Welfare and Recreation
7. Natural Resources
8. Civil Protection
9. Industrial Resources and Production
10. Transportation and Communication
11. Legislation
12. Public Relations and Counter Propaganda
13. Finance
14. Local Co-operation
15. Surveys and Fact Findings

The Sub-Committee on Natural Resources is concerned with water, minerals, forests and soils, in which fields its members are experts. Water supply problems related to defense are handled by this sub-committee.

One of the first and foremost recommendations of the New Jersey Defense Council was the construction of a new major water supply for the northern metropolitan district, and the inter-connection of the individual water systems in the district as recommended by the State Water Policy Commission on the basis of a comprehensive survey made in 1939–40. Recognizing the importance of protecting existing water works properties from damage by sabotage, subversive activities or any emergency, the Council directed a survey of the 273 water supply systems of the State to determine what steps, if any, had been taken by the owners of the individual systems. This survey was made by the natural resources sub-committee.

On about April 1, 1941, a letter was forewarded to each water works owner requesting him to advise what he had done or planned to do to protect the properties under his supervision. In answer to the request, 159 individuals replies or 58.2 per cent of the total, were received. All of the important water supplies were represented in the response.

Defense Measures of New Jersey Water Works

The various subjects covered in the replies included: (1) reserve equipment and supplies, (2) control of visitors, (3) guards and patrol, (4) lighting, (5) covering of vulnerable places, (6) fencing, (7) special testing, (8) emergency crews, (9) record maps, (10) inter-connections, and (11) general comments. Of these subjects, reserve equipment and supplies and inter-connections were mentioned most frequently; guards and fencing and then lighting followed (Table 1). General comments indicated that the water works officials were keenly alive to the problem, but were handicapped mostly by lack of money to

TABLE 1

Summary of Replies to Questionnaire on Water Works Protection

Number of Questionnaires Sent	273
Number of Replies Received	159
Percentage of Questionnaires Returned	58.2

PROTECTIVE MEASURE	NO. OF TIMES MENTIONED
Inter-Connections	37
Reserve Equipment and Supplies	35
Guards—Patrol	23
Fencing	20
Lighting	17
Control of Visitors	12
Record Maps	8
Covering	4
Special Testing—Samples	4
Emergency Crews	3
General Comments Only	94

carry out many excellent ideas. As to funds that may be available to aid municipalities on defense measures, the Communities Facilities bill (HR 4545) pending in the Congress, has passed the House in Washington and was reported out favorably by the Senate Committee on June 17. This bill appropriates $150,000,000 and is a financial assistance measure. Funds might be available under it for such a project as an inter-connection vital to the delivery of water to a defense industry, but protection of water works is properly a state and local function.

The general attitude expressed in this survey to date may be summed up in the statement of one of the officials of a large water works:

"We believe that the question of defense of the water supply system of this city should be controlled locally during the present emergency, with reasonable military protection afforded through our state and local defense agencies. We suggest that the necessary water works equipment and material necessary for maintenance of a water supply system be given priority consideration."

An official of a small water works at a fishing village on the Atlantic coast writes:

"Your inquiry seemed almost comparable to that old threadbare story of the poor colored man who was asked if he had change for twenty dollars. Well, we also thank you for the compliment."

Then he adds in a more serious vein:

"I appreciate the work you are doing to stir up the larger water utilities to be prepared for any eventuality. Under conditions like the present, no one knows what may happen, and it is quite possible that a little inconspicuous plant like our own might escape, while some larger and more prominent outfit was put out of commission. Then, even a small drink would be better than none."

The owner of one of the largest reservoirs in the state had a large sign, reading "Planes Keep Away," erected on the dam at the request of the State Aviation Commission. Instructions to report the identification numbers of any planes violating the notice were given. To date no reports have been necessary.

In a large city, an emergency crew in three eight-hour shifts, with fully equipped truck and with short wave radio tuned to the city police radio station, is available at a service yard in the center of the city to handle all leaks and breaks and similar trouble requiring immediate action. Another large system with several storage reservoirs has installed stop planks below outlet gates to back up water so as to flood the gates and prevent interference with them.

The utilities officer of one of the large military cantonments writes:

"While it is very evident that a protection procedure should be adopted at once on the part of New Jersey water works plant operators, would advise that we initiated extra precautionary measures some time ago.

"Whereas it would not be our policy to advise in detail what meth-

ods we are employing to protect our plants, it is evident to any civilian observer that we are surrounding both our pumping and filtration plants with a high wire fence in addition to employment of 24-hour armed sentries."

Another owner uses phosphorescent paint on the tops of certain hydrants to act as guides in case of "blackout." Still another recommends a rigid check-up of personnel, including fingerprinting, to detect persons with criminal records; and recalling of all company passes and issuing new ones to authorized persons.

A common and important suggestion is the wider use of shutoff valves in order to isolate small areas in case of emergency breaks or damage to distribution mains. The pooling of stocks of equipment and supplies is worthy of careful study. Record of such equipment should be compiled and kept at several central offices for emergency use.

Need for Outside Aid

Many water works officials felt the need of outside aid in case of extreme emergency with which they were unable to cope. This situation was brought out at a conference held on May 16, 1941, to which all water works officials of the northern metropolitan district were invited by the New Jersey Defense Council. The Council was represented by its chairman and the chairmen of the Sub-Committees on Civil Protection, Natural Resources and State Guard. This conference afforded an opportunity for the many water works officials who attended to exchange ideas on local protective measures and to inform the Defense Council representatives as to their needs for outside aid. As a result, a plan was developed upon the suggestion of the Superintendent of the New Jersey State Police, whereby a survey is now under way by representatives of the State Police and the State Water Policy Commission. This survey includes a personal inspection of the water works properties, such as dams, reservoirs, gate houses and other control points, aqueducts, tunnel portals, pumping stations, filtration plants and other vulnerable points, more particularly in rural areas. It was brought out that in the larger cities the municipal police force was instructed to guard and protect water works properties within the municipal limits, the State Police force being limited in size and having many other duties of an emergency character to perform. The survey will develop a plan of mobilization in case of emergency call for aid. Maps showing ways

of approach to vulernable spots, the number of men necessary to cope with a given situation and other valuable information and ideas are developed in co-operation with the water works officials. While the survey has been under way for only a month, it is receiving unanimous support by all concerned, and all indications point to satisfactory results. The survey will be extended throughout the entire state as may be necessary.

Inter-Connection Survey

As mentioned above, inter-connections between adjacent water supply systems are considered by water works officials one of the best protective measures against failure of the water plant due to an emergency. The term inter-connection as used here covers permanent pipe connections between adjacent water supply systems intended for use intermittently in case of emergency or temporary shortage of water in either system. The ability to transfer water in either direction of course depends on the relative pressures at any given time.

In 1929, when the New Jersey State Water Policy Commission was created, the importance of inter-connections as a method of pooling existing sources of supply was recognized. The law setting up the Commission (R.S. 58: 1–34) included the following provision:

"The Commission may, upon petition or upon its own initiative, after hearing, upon notice, require by order in writing the interconnecting of public water supply systems, whether in public or private ownership, whenever it determines that the public interests requires that such connection be made, and require the furnishing of water by means of any such system to another, upon fair compensation, reasonable rates and just and equitable terms to be prescribed by the commission, which rates shall be subject to review and adjustment by the board of public utility commissioners."

Early attempts to carry out the provisions of the law were not very successful because of the depression and the falling off of water consumption. Late in 1938, however, a limited appropriation was made for a survey of the need for inter-connections in three metropolitan areas. Active work started early in 1939 and a preliminary report was made early in the summer of that year. A severe drought during the fall and winter of 1939–40 emphasized the importance of such an undertaking and the need for some of the suggested inter-connections.

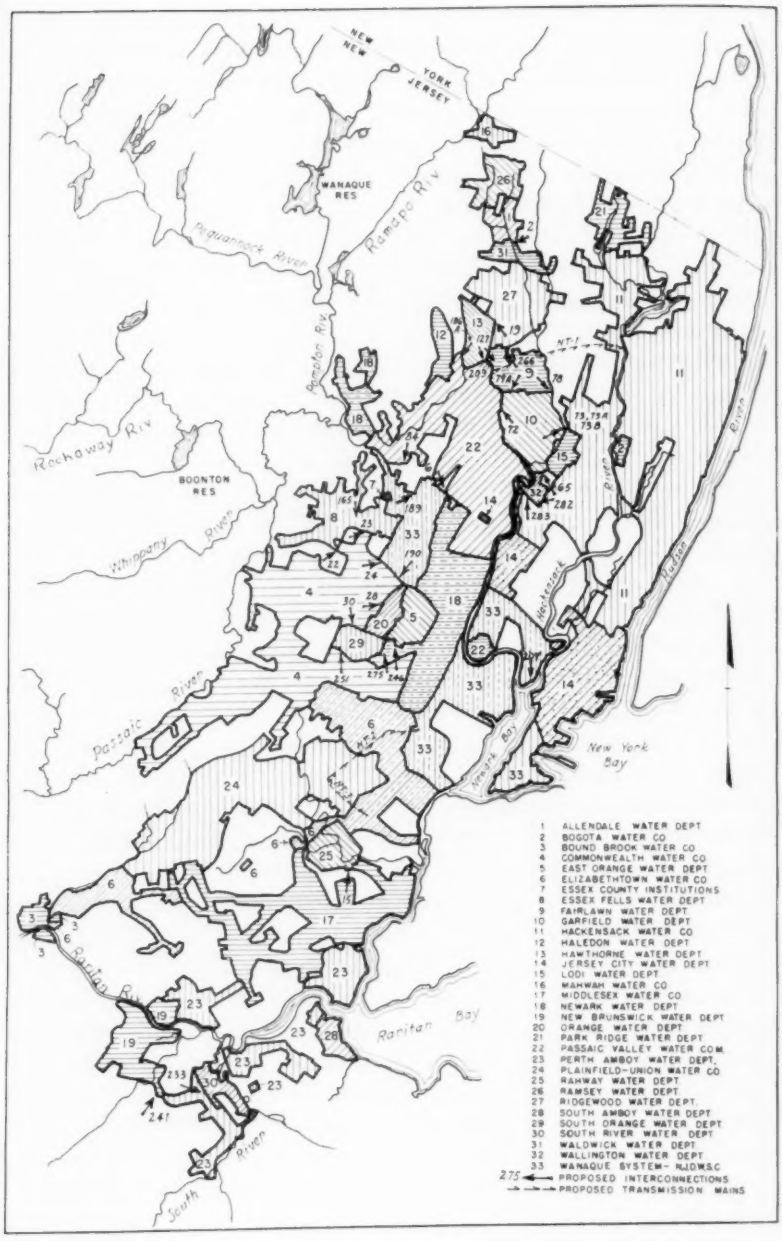

FIG. 1. Inter-Connections of Water Supply Systems—Northeastern New Jersey

Northern Metropolitan District

The largest and most important area under survey was the northern metropolitan district (Fig. 1), embracing the counties of Bergen, Essex, Hudson, Middlesex, Passaic and Union and a small part of Somerset—the metropolitan area across the Hudson River from New York City. This district is served by 33 separate water supply systems. The area contains 151 separate municipalities, covering an area of 630 sq.mi. Several of the systems deliver water to individual areas having separate retail organizations, there being 58 separate municipal water departments, 10 water companies and one water commission retailing water. Five of the 33 water systems furnish 75 per cent of the water. The survey developed that there

TABLE 2

Proposed Transmission Pipe Lines in Northeastern New Jersey

NO.	LOCATION		LENGTH OF MAIN	DIAMETER OF MAIN	ESTIMATED COST
	Between Municipality	And Municipality			
			ft.	*in.*	
NT-1*	Paterson	New Milford	67,500	42	$734,000
NT-2†	Newark	Roselle	29,350	60	1,043,000
NT-3†	Roselle	Linden	14,000	36	223,000
Total					$2,000,000

* Would connect system of Passaic Valley Water Com. with that of Hackensack Water Co.

† Together NT-2 and NT-3 would connect the Wanaque system (at end of Newark–Elizabeth line) with Elizabethtown Water Co. and Plainfield-Union Water Co.

are 211 existing inter-connections, of which 103 are actually service connections in constant use. The remaining 108 are normally not in use and are available for use in emergency. The difficulty with many of the inter-connections is their small capacity to transfer water; others by virtue of changes in the distribution systems have become outmoded or useless. On the other hand, there are a number which are in daily use and are vital to the water supply service of many of the municipalities.

One of the principal objects of the study was to evaluate these inter-connections and to determine what, if any, additional facilities should be provided. Flow tests were made adjacent to points of inter-connection and the actual amount of water that could be

TABLE 3

Proposed Essential Inter-Connections in Northeastern New Jersey—Area 1

NO.	LOCATION		MAINS OWNED BY		SOURCES OF SUPPLY		HYDRAULIC GRADE AT INTER-CONNECTION		VOLUME TRANSFERABLE		ESTIMATED COST
	Municipality	Site	Owner 1	Owner 2	Owner 1	Owner 2	Owner 1	Owner 2	#1 to #2	#2 to #1	
									m.g.d.	*m.g.d.*	
2	Allendale	Franklin Turnpike at Waldwick Line	Allendale	Waldwick	Allendale	Waldwick	505	400	0.2	0.0	$1,250
*22	West Orange	Eagle Rock Ave. at Roseland Line	Roseland	Commonwealth Water Co.	Essex Fells	Commonwealth Water Co.	663	666	0.1	0.2	2,700
*23	West Orange	Pleasant Valley Way at Verona Line	Verona	Commonwealth Water Co.	Essex Fells	Commonwealth Water Co.	664	679	0.2	0.2	1,250
*24	Montclair	Mountain Ave. at Town Line	Commonwealth Water Co.	Montclair	Commonwealth Water Co.	Wanaque†	690	687	0.2	0.4	800
28	West Orange	Main Street at City Line	Orange	Commonwealth Water Co.	Orange	Commonwealth Water Co.	415	404	0.5	0.1	2,000
*30	South Orange	Wyoming Ave. at Luddington Rd.	South Orange	Commonwealth Water Co.	South Orange	Commonwealth Water Co.	599	681	0.0	0.3	1,500
65	Garfield	Midland Ave. at Boro Line	Garfield	Wallington	Garfield	Wallington	181	167	0.1	0.1	2,500
72	East Paterson	River Drive, north of Market St.	Passaic Valley Water Com.	East Paterson	Wanaque	Garfield	297	194	0.6	0.0	2,500
73	Lodi	Market St. at Saddle River	Lodi	Saddle River	Lodi	Garfield	167	197	0.0	0.2	2,500
73-A	Lodi	Market St. at Rochelle Park	Lodi	Hackensack Water Co.	Lodi	Hackensack Water Co.	167	284	0.0	0.2	1,500
73-B	Saddle River	Market St. at Rochelle Park	Hackensack Water Co.	Saddle River	Hackensack Water Co.	Garfield	284	197	0.2	0.0	3,000
78	Fairlawn	Swamp Rd. at Saddle River Line	Saddle River Township	Fairlawn	Garfield	Fairlawn	186	250	0.0	0.1	2,500
79-A	Fairlawn	Willow St. at Cyril Ave.	East Paterson	Fairlawn	Garfield	Fairlawn	185	242	0.0	0.3	1,750
*84	Little Falls	North Portal of 2 Tunnels	Jersey City	North Jersey Dist. Water Supply Com.	Jersey City	Wanaque	241	260	0.0	25.0	12,500

*84	Little Falls	North Portal of 2 Tunnels	Jersey City	North Jersey Dist. Water Supply Com.	Jersey City	Wanaque	241	260	0.0	25.0	12,500
*86	Clifton	Chittenden Rd. near Broad St.	Jersey City	Newark	Rockaway	Pequannock	241	390	0.0	25.0	12,500
115	Rahway	Woodbridge Rd. at Randolph Ave.	Rahway	Middlesex Water Co.	Rahway	Middlesex Water Co.	107	251	0.0	0.4	2,000
119	Hawthorne	Rock Rd. near Isabella Ave.	Ridgewood	Hawthorne	Ridgewood	Hawthorne	309	368	0.0	0.2	2,500
*127	Fairlawn	Heights Ave. to Lincoln Ave.	Hawthorne	Fairlawn	Hawthorne	Fairlawn	377	241	0.2	0.0	2,500
165	Caldwell	Bloomfield Ave. near Prospect St.	Essex Fells	Caldwell	Essex Fells	Essex Fells	600	600	0.3	0.0	1,500
186-A	Hawthorne	N. 16th St. at Prescott Ave.	Passaic Valley Water Com.	Hawthorne	Passaic Valley Water Com.	Hawthorne	400	435	0.0	0.3	1,250
189	Cedar Grove	Bradford at Cedar Grove Line	Montclair	Cedar Grove	Wanaque	Wanaque	676	676	0.2	0.0	5,000
190	West Orange	Orange Heights Ave. at Gregory Ave.	Commonwealth Water Co.	Orange	Commonwealth Water Co.	Orange	417	420	0.3	0.2	2,500
207	Kearny	Federal Ship Yard	Kearny	Bayonne	Wanaque	Wanaque	185	185	1.0	1.0	5,000
‡209	Fairlawn	River Rd. west of Maple Ave.	Passaic Valley Water Com.	Fairlawn	Passaic Valley Water Com.	Fairlawn	160	241	1.0	1.0	2,000
233	South River	New Brunswick Rd. at E. Brunswick Line	E. Brunswick	South River	Perth Amboy	South River	202	213	0.3	0.3	1,300
241	Milltown	Main St. at E. Brunswick Line	E. Brunswick	Milltown	Perth Amboy	New Brunswick	197	192	0.4	0.0	1,500
251	South Orange	Wyoming Ave. at Lennox Ave.	Commonwealth Water Co.	East Orange	Commonwealth Water Co.	East Orange	422	360	0.5	0.0	2,500
*266	Fairlawn	S. Maple Ave. at Glen Rock Line	Fairlawn	Ridgewood	Fairlawn	Ridgewood	243	312	0.0	0.2	2,500
275	South Orange	South Orange Ave. at Dover St.	Newark	South Orange	Pequannock	South Orange	331	413	0.3	0.0	2,000
*282	Wallington	Mt. Pleasant Ave. at Paterson Ave.	Hackensack Water Co.	Wallington	Hackensack Water Co.	Wallington	251	190	0.5	0.0	1,250
*283	Wallington	Locust Ave. at Paterson Ave.	Hackensack Water Co.	Wallington	Hackensack Water Co.	Wallington	265	174	0.2	0.0	1,250
346	East Orange	Clinton St. at S. Orange Ave.	East Orange	Newark	East Orange	Pequannock	353	352	0.4	0.6	3,000
Total											$90,300

* Urgent; total cost of these is $38,750.
† Wanaque supply operated by North Jersey Dist. Water Supply Com. for eight participating municipalities.
‡ Originally listed as urgent.

transferred under conditions of extreme demand was computed. The correlation of water pressures in the two adjoining systems was considered and finally two rates of flow were established, one representing extreme flow in emergency and the other the flow that could be sustained over a period of days. The latter was used as a basis for selecting the points of inter-connection to be recommended.

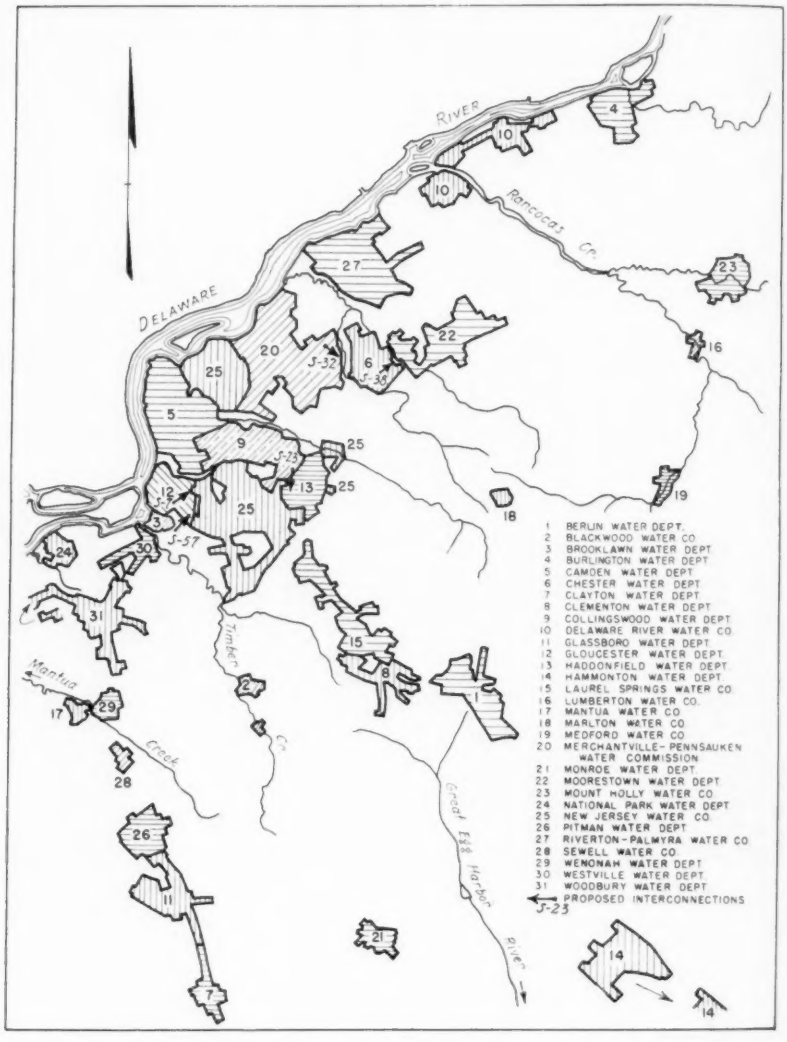

FIG. 2. Inter-Connections of Water Supply Systems—Camden Area

The proposed inter-connections were divided into two classes "A" and "B," the primary class (A) including those recommended for immediate construction and the secondary class (B), those which may be constructed to advantage but are not urgently required. As a result of the survey, 35 inter-connections of Class A, at an estimated cost of $2,090,300, were recommended. Of these, three are long transmission pipe lines ($2,000,000) and 32 are short inter-connections ($90,300) (Tables 2 and 3).

Camden Area

The Camden area (Fig. 2) across the Delaware River from Philadelphia includes Camden County with adjacent parts of Burlington and Gloucester counties and a small portion of Atlantic. This area is served by 31 separate water supply systems embracing 62 separate municipalities and communities. With the exception of supplies in the immediate vicinity of Camden, many of the sources are isolated and do not readily lend themselves to inter-connection. The consumption in the Camden area is 32 m.g.d. and the population supplied, 425,000. The problem is not so great as in the northern metropolitan district; nevertheless it demands attention.

During an unusual flood—September 1, 1940—several water pumping stations were inundated and put out of commission. Some existing inter-connections delivered the only water that reached some towns, while others that were without their regular supply obtained water from private wells. In another flood stricken town, air-conditioning system wells for a movie theater were connected into the distribution system until the municipal supply was restored.

The survey of the Camden Area shows that five Class A inter-connections at an estimated cost of $51,500 will serve to strengthen the water facilities of the area (Table 4). Future needs of the communities served will be aided materially by the installation of ten additional inter-connections. The need for some of these was well demonstrated during the aforementioned flood.

Atlantic City Area

The Atlantic City area (Fig. 3) on the South Jersey coast, comprising the eastern part of Atlantic County and the northeastern part of Cape May County, is served by 11 water supply systems embracing 16 separate municipalities and communities. The normal consumption in the Atlantic City area is 15 m.g.d. and the population served,

TABLE 4

Proposed Essential Inter-Connections in Vicinity of Camden—Area 2

NO.	LOCATION		MAINS OWNED BY		SOURCES OF SUPPLY		HYDRAULIC GRADE ELEVATION AT INTER-CONNECTION		VOLUME TRANSFERABLE		ESTIMATED COST
	Municipality	Site	Owner 1	Owner 2	Owner 1	Owner 2	Owner 1	Owner 2	$1 to $2	$2 to $1	
									m.g.d.	*m.g.d.*	
S-7	Camden and Gloucester	Broadway-Fairview Ave. to King St.	Camden	Gloucester	Camden	Gloucester	104	97	0.6	0.2	$25,000
S-23	Haddonfield	Kings Highway at Chews Landing Rd.	New Jersey Water Co.	Haddonfield	New Jersey Water Co.	Haddonfield	176	200	0.5	0.5	2,500
S-32	Pensauken Township and Chester Township	Maple Ave. at Boundary Line	Merchantville-Pensauken Water Com.	Chester Township	Merchantville-Pensauken Water Com.	Chester Township	211	175	0.5	0.2	11,500
S-38	Chester Township and Moorestown	Moorestown Pike at boundary line	Chester Township	Moorestown	Chester Township	Moorestown	173	167	0.3	0.3	10,000
S-57	Gloucester and Mt. Ephraim	Market St. at boundary line	Gloucester	Mt. Ephraim	Gloucester	New Jersey Water Co.	104	165	0.3	0.3	2,500
Total											$51,500

125,000. Some of these systems have difficulties largely because of high peak drafts in the summer. The 11 systems are inter-connected as fully as present conditions warrant. The supply for Atlantic City comes from the mainland and is carried five miles across salt meadows to the beach. In case of interruption of the supply from the main-

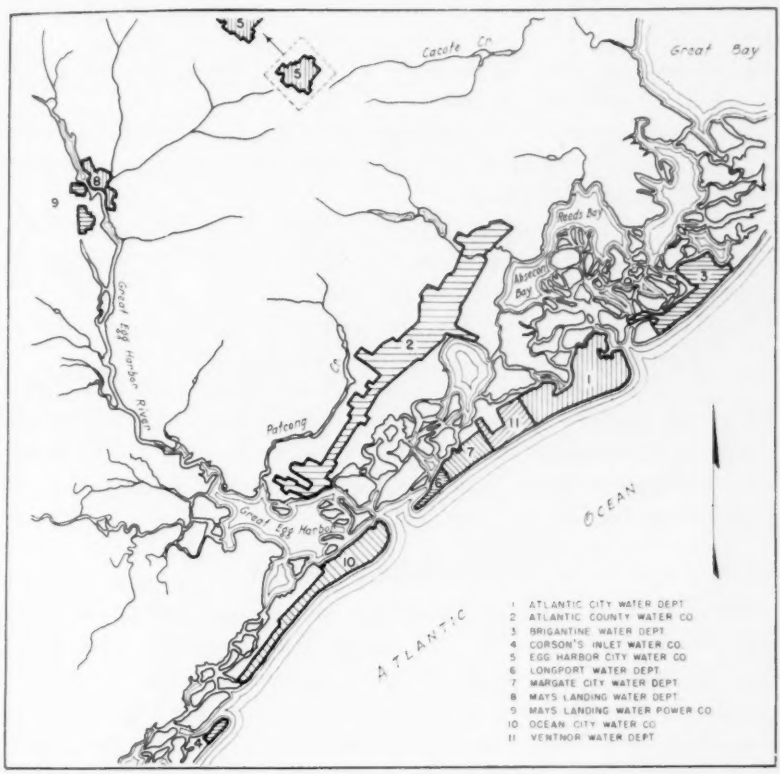

FIG. 3. Inter-Connections of Water Supply Systems—Atlantic City Area

land, a supply for a limited period could be obtained from wells serving the large hotels on the beach.

Conclusions

The survey on inter-connections, then, has indicated a number of general conclusions, as follows:

1. Some of the larger supplies are moderately well inter-connected. Quantities up to 25 m.g.d. may be transferred between some of them without any construction work.

2. Several new large inter-connections and a number of small ones will be required to assure reasonable transfer of water between existing supplies.

3. These interconnections will not only be of inestimable value at present, but many will become essential in the transmission and distribution of water from any future source of supply that may be developed.

4. Population growths indicate a steadily increasing residential or suburban demand for water.

5. War industries are now taking up the slack existing in the water consumption in large cities which was caused by a decrease in population and industrial declines.

6. The matter of guaranteeing the continuity of defense activities demands an adequate water supply, which in turn requires full co-operation and co-ordination of facilities.

7. Water pressure elevations that now exist permit many one-way transfers of water but tend to prevent interchange.

8. The existence of reduced sizes of mains at municipal limits lessens the value of some otherwise useful points of inter-connection.

9. The volume of water actually available in a drought, conflagration, or other emergency, is generally less than the quantity frequently ascribed to the supplies studied.

Prospects for the Future

While this paper has dealt with the strengthening and protection of water works properties to meet emergencies that may arise in the uncertain days ahead, the writer is not unmindful of the fact that by pooling all the sources of water supply in the northern metropolitan district of New Jersey they will not provide a safe surplus to meet the demands of an extremely dry year. The safe yield of the 33 water supply systems in the district is estimated to be 305 m.g.d. by assuming a 25 per cent reserve in surface storage reservoirs of the principal systems, and 340 m.g.d. if such a reserve is exhausted. In 1929, the total consumption was 305 m.g.d., in 1933 it had dropped to 255 m.g.d., but in 1940 it was up to 271 m.g.d. During the year 1940–41 the consumption has increased rapidly due to industrial activities in the defense program. The last quarter of 1940 averaged 275 m.g.d., while the first quarter of 1941 averaged 290 m.g.d., and the months of April and May, 1941, 297 m.g.d. This is not a comfortable situation with further increases in consumption to be

expected from the ever-increasing national defense activities, coupled with a deficiency in rainfall from January to the end of May that provided only about 75 per cent of the normal runoff, with the driest May of record at many stations. Recent heavy rains in June, however, have partly wiped out the deficiency in precipitation since the first of January and have eased the situation, at least temporarily. The water situation in the rest of the State is in better shape. Additional demands can be met through development of nearby sources —generally artesian wells—and through inter-connections between adjoining systems.

No doubt we can "tighten our belt" if necessary, even in the use of water, but the prudent move would be to follow the advice of the water engineers to the Legislature and proceed with the development of a major water supply project for the northern metropolitan district at once.

For the immediate future, the water works officials are determined to strengthen and protect their facilities to the utmost, realizing that they are responsible for serving the people and industries of the state an important commodity for which there is no substitute in peace or emergency.

Progress in Water Conditioning Methods to Inhibit Corrosion

Committee Report

IN VIEW of the difficult and controversial nature of its subject, the Committee on Water Conditioning Methods to Inhibit Corrosion wishes at this time to present to the membership of the Association an outline of its present and proposed future activities. It is hoped that much in the way of suggestions, information, and criticism will result from this presentation, and that the Committee will be enabled thereby to serve the Association more effectively.

A portion of the present work of the Committee is directed toward the preparation of a report on the theory, practice, merits and disadvantages of the common methods of anti-corrosion treatment. This report is designed to include a general discussion of each type of treatment and a compilation of information obtained from operators and chemists who have used or are using the treatment. To this end, it has been attempted to apportion discussion of the methods among the individual committee members. A questionnaire (see page following) has been prepared for plant operators using the various anti-corrosion treatments. The committee feels that more valuable information is obtainable from operating results than from any other source, and *strongly urges that all plant operators using anti-corrosion treatment give the Committee the benefit of their experience.* Blank copies of the questionnaire will be furnished by any member of the Committee, but it is reproduced here so that the information may be sent directly to any member, if desired.

The bulk of the information so far received relates to the use of lime, which appears to be the most widely used form of treatment.

A committee report presented on June 25, 1941, at the Toronto Convention by Edward W. Moore, Chairman of the Committee and Assistant Professor of Sanitary Chemistry, Harvard Graduate School of Engineering, Cambridge, Mass.

Committee on Water Conditioning Methods to Inhibit Corrosion

Questionnaire on Anti-Corrosion Treatment

Date _____ *194*

1. Name and location of town or water company.

2. Source of water.

(a) Lake	(d) Shallow wells
(b) Stream	(e) Infiltration galleries
(c) Deep wells	(f) Springs

3. General treatment of water (e.g. coagulation, rapid sand filtration, etc.).

4. Characteristics of water before receiving anti-corrosion treatment.

pH	Magnesium
Carbon dioxide	Total solids
Alkalinity	Dissolved solids
Hardness	Iron
Dissolved oxygen	Other significant data
Calcium	

5. Kinds of piping in system.
   (a) Mains
   (b) Services
   (c) House piping

6. Where was corrosion difficulty experienced (or anticipated)?

7. Reason for adopting anti-corrosion treatment (e.g. red water, failure of piping, etc.).

8. What type or types of treatment tried and experience with each? What type finally adopted?

9. Date of adoption.

10. How much and where applied?

11. Characteristics of treated water.

pH	Hardness
Carbon dioxide	Iron
Dissolved oxygen	Other significant data
Alkalinity	

12. What results have been obtained?

Remarks:

The Committee is particularly anxious to have more information on the use of silicate, soda ash, metaphosphates, limestone beds, caustic soda, and other more unusual treatment methods.

Another portion of the work of the Committee has been devoted to collection of information about changes in the distribution system caused by alteration of anti-corrosion or other treatment of the water. The conclusions so far reached will be discussed presently.

It has been suggested that at some future date the Committee also consider treatment methods for the protection of hot-water systems in isolated buildings, and the treatment of non-potable supplies used for industrial purposes. Again, it has been suggested that a better definition of some of the terms now used loosely to describe corrosion phenomena would be a worthy undertaking. Finally, the development of a standard field test to measure the corrosiveness of water has also been suggested. Other suggestions of this kind will be welcomed.

Effect of Changes in Treatment on Distribution Systems

A few unpleasant experiences reported by plant operators using some of the newer anti-corrosion treatments have served to focus attention upon the fact that there is a very delicate chemical and biological equilibrium set up inside a distribution system. Any drastic change in the condition of the water sent into the system alters this equilibrium, with results ranging anywhere from minor, undetectable changes in the quality of water delivered, to extensive sloughing of pipe deposits with resulting red or turbid water, increased bacterial counts and serious taste and odor problems. In general the effect is in proportion to the amount of change in the quality of the water sent to the system, and consequently, such changes are best made a little at a time.

Anti-corrosion treatments are by no means the only offenders in this respect, and it would be invidious to single them out. Chlorine and chloramine treatments have produced similar effects on occasion, and troubles have occurred even when filtered water was first sent through a system, previously fed with unfiltered water, or when the pH of the water was altered. In short, the alert operator will be prepared for occurrences of the sort described whenever any great alteration is made in the treatment of the water. Active sampling programs, flushing, and careful attention to conditions at dead ends

are recommended if there is any reason to expect difficulties in the system. It should be emphasized, however, that serious trouble due to change in water treatment is the exception rather than the rule, and should not be regarded as a deterrent to the trial of new treatment methods.

It appears from the information at hand that two types of distribution systems are particularly prone to such difficulties; i.e., those previously handling water containing little or no residual chlorine, and therefore likely to have heavy slime growths; and those which have acquired heavy internal incrustations of ferric and manganic hydrates, either by corrosion or deposition. The former are particularly likely to be affected by increased chlorine and chloramine dosage, producing difficulties with taste and odor, turbidity, and increased bacterial counts; the latter are influenced mainly by pH changes and by certain anti-corrosion treatments such as the silicates and phosphates, with the production of red, black, or turbid water and sometimes increased bacterial counts.

Present information does not yet permit prediction of the extent and duration of distribution system disturbances, but it is definitely known that they tend eventually to clear up as a new equilibrium is established within the pipe. In some instances this clearing up has required several months; in others it has been complete within a few days. At Eagles Mere, Pa., for example, where silicates had been used for inhibiting of corrosion, the introduction of a more alkaline silicate produced red water and an increase in iron content to 3.8 p.p.m. Within two days, however, the iron had dropped back to 0.35 p.p.m.

Effect of Metaphosphates on Distribution Systems

There are, to date, about 150 plants using sodium hexametaphosphate in soft water for the control of corrosion. The Committee is not yet prepared to report on the merits of this type of corrosion control as compared with older methods. There is, however, a need for discussion of the effect of hexametaphosphate on the chemical and biological balance within distribution systems, since a few operators have reported difficulties arising from the use of the material.

According to information furnished by the manufacturers of the product, only a small proportion (about 3 or 4 per cent) of those

adopting metaphosphate treatment have experienced upsets in their distribution systems. These difficulties have occurred primarily in systems in which iron- or manganese-bearing waters have deposited hydrates of these metals on the walls of the piping. Metaphosphates have a tendency to remove such deposits, sometimes with the production of red, black or turbid water. According to the manufacturers, frequent and prolonged flushing will clear up such troubles within a few days; in unflushed systems they have been known to last three months. The statement seems reasonable in the light of experience with distribution system difficulties caused by other changes in treatment. Again according to the manufacturers, no difficulty has been experienced when the deposits in the mains are due to corrosion of the piping itself; these deposits appear to be different in character from those formed by deposition of dissolved iron and manganese. The policy of the manufacturers in introducing metaphosphate treatment of a supply is to avoid any drastic change in its quality other than the introduction of the material itself; this procedure is to be recommended in all cases.

The Committee feels that the difficulties encountered in a few systems should not deter anyone from trying metaphosphate treatment. Caution is indicated when the mains are encrusted with iron or manganese deposits, and active flushing will be necessary to prevent disturbances of long duration. Reports of increases in the numbers of bacteria in the water due to the addition of metaphosphate seem not too well substantiated, nor do they indicate any danger to health.

If difficulties are anticipated, it is advisable, if possible, to apply metaphosphates to an isolated portion of the system before adopting it for the whole system. In this way, any sloughing of deposits will be confined to a part of the system, and the possibility of applying the material to the rest of the system, in such a way as to avoid such troubles, may be evaluated.

Solution of Lead by Metaphosphates

At the April, 1941, meeting of the New England Health Institute, it was suggested by Dr. Fairhall of the Division of Industrial Hygiene of the U. S. Public Health Service that metaphosphates might have a dispersing action on old deposits in lead pipes. In correspondence with the chairman of this Committee, Dr. Fairhall cited some experi-

ments showing that the solubilities of certain insoluble lead compounds, such as the carbonate, silicate, and sulfate were materially increased in water containing 1 per cent sodium hexametaphosphate. This quantity is 10,000 p.p.m., whereas the quantity of metaphosphate normally used in water supply systems is 4 p.p.m. or less. It does not, therefore, necessarily follow from Dr. Fairhall's experiments that lead compounds will be taken up by metaphosphate-treated water under practical conditions.

The subject is, however, of the greatest importance to water works men, and the Committee is working to gather all the information available. A recent article by G. B. Hatch (Jour. A.W.W.A., **33**: 1179 (1941), described some investigations on the influence of sodium hexametaphosphate on lead. These experiments showed definitely that metaphosphate inhibits the corrosion of metallic lead.

While it may be true that metaphosphate will retard the corrosion of metallic lead, the Committee feels that the experiments cited above do not conclusively prove that metaphosphate-treated water will not take up lead from the coatings of basic carbonate and other lead salts existing on the interior of old lead pipes. Preliminary experiments in the laboratory of the Chairman have indicated that the solubility of basic lead carbonate may be increased as much as three- to six-fold by doses of metaphosphate of 2 to 4 p.p.m., and as much as ten-fold by doses of 10 and 20 p.p.m. For example, in one set of experiments, the amounts of lead found in waters containing 0, 1, 2, 4 and 10 p.p.m. of sodium hexametaphosphate were 0.5, 0.8 3.0 and 4.0 p.p.m. respectively. These solubilities were measured by allowing the treated and untreated waters to stand 24 hours in contact with basic lead carbonate, filtering, and determining lead. Experiments were made involving both quiescent contact and continuous shaking. Similar increases were not observed in the solubilities of litharge and lead sulfate, but the solubilities of these compounds in untreated water are considerably greater than that of the basic carbonate.

The results of these experiments are not regarded by the Committee as conclusive, or necessarily representing the true situation in a lead service pipe in which metaphosphate-treated water is being introduced for the first time. Further experiments are in progress. In the meantime, the committee feels that wherever metaphosphate treatment is instituted in a system containing lead services, the lead

content of tap samples drawn after standing overnight in the services should be checked. Until such checks are made, persons using such services should be warned not to consume the water first drawn from the pipe in the morning. As a matter of fact, the consumption of water that has stood overnight in a service pipe of copper, zinc, or lead is hardly to be recommended whether or not the water be treated with metaphosphate.

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Program for Research on the Effects of Electric Grounding on Water Pipes

By Rolf Eliassen

THE grounding of electrical circuits in households and industry has long been practiced in the interest of public safety and the protection of machinery. In many instances, particularly in households, the most convenient method of grounding has been to connect the fixture or apparatus directly to the nearest water service pipe. The effect of the passage of electric current over the pipe on the quality of the water contained therein has been the subject of much discussion. Many water works men have observed a change in the characteristics of water from some faucets when the grounding has been removed from the water pipe.

Very little experimental work has been done on this subject, with the exception of a study made by the Hackensack Water Company some years ago (1), and some theoretical research by the Technical Sub-Committee of the American Research Committee on Grounding (2, 3). The proposed study being sponsored by the American Water Works Association, and conducted at the Sanitary Engineering Research Laboratory of New York University, under the supervision of the author, is an attempt to determine the effect of alternating and direct current on the quality of water passing through various metallic pipes.

The problem is closely allied with that of the corrosion of metals. Excellent research work has already been done in this general field over a period of years and has been the subject of many articles and books (4). The problem of the effect of grounding on the external corrosion of pipes buried in the soil has been studied extensively, and definite conclusions have been established (5), not the least of which is the development of cathodic protection (6).

A paper presented on June 24, 1941, at the Toronto Convention by Rolf Eliassen, Associate Professor of Sanitary Engineering, College of Engineering, New York University, New York City.

The effect of grounding on the internal corrosion of pipes is somewhat different in that the potential drop between the pipe and the surrounding soil is not the controlling factor. The galvanic action resulting in corrosion takes place between adjacent joints, of differing potential in the metal, causing the metal to leave the pipe and dissolve in the water flowing through. The presence of metallic ions in the water may affect its quality and render it undesirable for human consumption. It is evidenced by such common phenomena as the staining of plumbing fixtures, the occurrence of red water and certain characteristic tastes and odors (7).

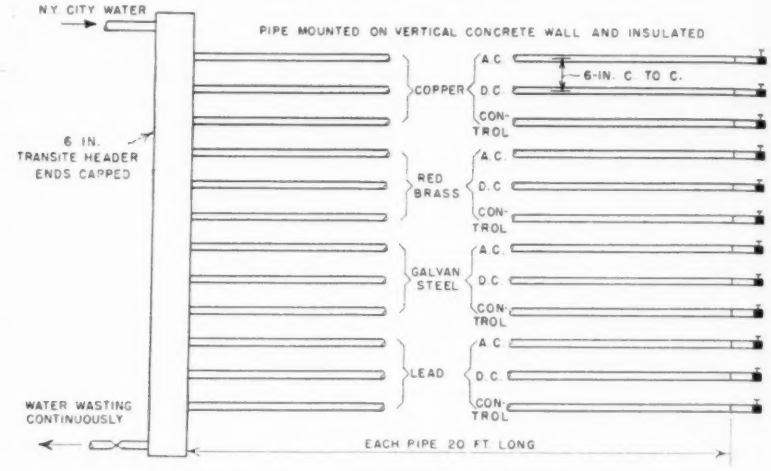

FIG. 1. General Arrangement of $\frac{3}{4}$-Inch Pipes in Experimental Set-Up

Proposed Experimental Procedure

The approach to this problem will be an experimental one. A series of pipes will be set up, water held in them for various lengths of time, and analyses made of the water entering and leaving the pipes. The apparatus is illustrated in Fig. 1. Four different pipe materials—copper, red brass, galvanized steel, and lead—will be used. The pipes will each be 20 ft. long and spaced 6 in. center to center in a vertical bank, insulated from each other and from the wall. Three pipes of each material will be used, with alternating current applied to four pipes, direct current to another four, and no current applied to the remaining four, which will act as controls.

Provision is being made for New York City water from the Croton and Catskill supplies to enter the pipes from a transite header through which there will be a continuous flow of water. This header will serve to give a uniform distribution of flow to the pipes being tested and will prevent any appreciable leakage of current from one pipe to another.

Alternating current will pass over the pipes in accordance with the circuit shown in the right-hand portion of Fig. 2. Each pipe will have a separate transformer and circuit, in order to prevent the flow

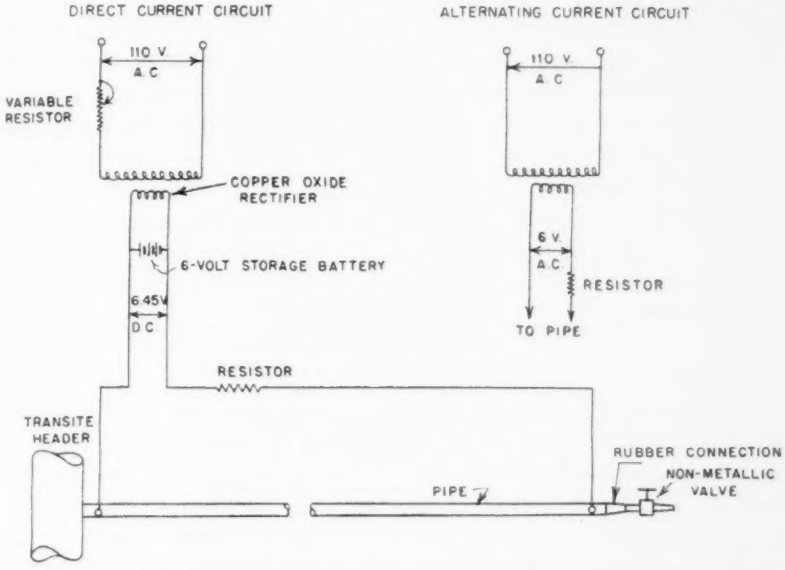

FIG. 2. Electrical Circuits for Alternating and Direct Current for Grounding Experiments

of current between pipes. By means of resistors, the current and voltage may be varied to cover the ranges met with in water works practice. Direct current will be applied in a similar manner, with the exception that a rectifier and a storage battery will be provided in each circuit to change the current characteristics from alternating to direct current.

The effluent end of each pipe will be provided with a non-metallic valve or stopcock connected to the pipe by means of a rubber or other non-conducting material tube. Experiments will have to be performed to determine the desired rates of filling and sampling the

water, the detention periods, and the velocity of flow in the pipes.

Samples of the water entering and leaving the pipes will be taken at frequent intervals and analyzed to determine any change in characteristics of the water having passed through the pipes. While it is desirable to observe any change in the quality of the water as it passes through a pipe subjected to grounding, the quality cannot readily be measured in terms of taste and odor or any other reaction to human stimuli. As yet, no quantitative method for the detection of these has been developed. Therefore, it will be necessary to make such observations as can be relied upon to be accurate from the quantitative, as well as qualitative, standpoint. The determination of the concentration of metallic ions in an aqueous solution is a most reliable measure of substances which might be added during the period the water remained in the pipe. Since the quality of water is largely measured by tastes and odors, an attempt will be made to establish a correlation between metallic ion concentrations and tastes and odors in water. The principal tests on the water entering and leaving the pipes, however, will be those to determine the concentrations of metallic ions.

Polarographic Method of Analysis

The analysis for the concentration of metals in the water could be made by the long and tedious methods of quantitative analysis, utilizing colorimetric or turbidimetric standards. At the low concentrations which will prevail in this research, however, these methods are not sensitive enough for results of the accuracy desired. Furthermore, since each analysis is so time-consuming, the number of analyses possible would also be limited. Therefore, a more accurate and faster method of analysis must be applied.

Such a method, the "Polarographic" method, does exist, but as yet it has not received the recognition of the water works field. The method is electrometric and applies certain principles of physical chemistry based on the change of free energy in a reversible reduction reaction. Essentially, it involves the application of an electrical potential between a dropping mercury electrode as cathode and a pool of mercury as anode in a vessel containing the solution to be analyzed. The theory and methods of application of polarography have been expounded and discussed at length in the scientific literature (8) since the original work of J. Heyrovsky. Like many other useful instruments, it is not necessary to be able to understand all of

the principles involved in order to utilize the apparatus to obtain the desired results. This simplicity makes it possible for any reasonably good analyst to apply it readily.

The arrangement of the dropping mercury electrode is illustrated in Fig. 3. A capillary tube connects a mercury reservoir with a vessel containing the solution to be analyzed. Drops of mercury issue from the end of the capillary tubing at the rate of one drop every two to four seconds, the drops reaching a maximum diameter of approximately 0.5 mm. at the time they break away from the capillary. At the bottom of the vessel there is a pool of mercury. The mercury reservoir is connected to one end of a circuit, comprised of a

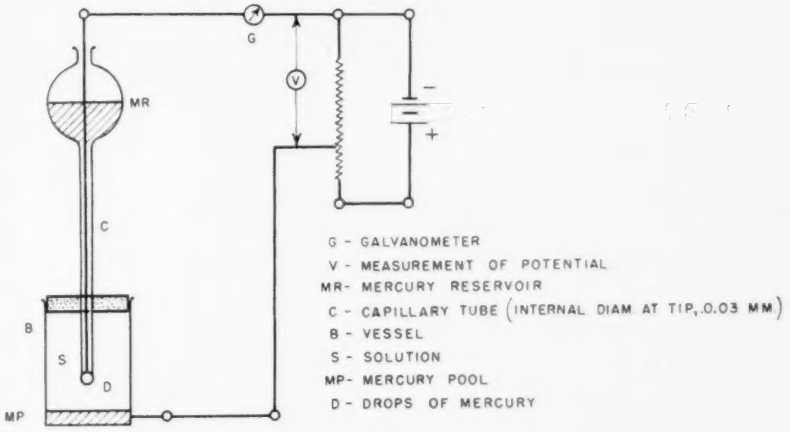

FIG. 3. Dropping Mercury Electrode and Polarograph Circuit

cell and a variable resistance arranged to give definite potentials across the terminals of the apparatus. The current passing through the circuit is measured by a galvanometer.

In the operation of this apparatus, a potential is applied across the terminals, with the solution to be analyzed contained in the vessel between the dropping mercury cathode and the anodic pool of mercury at the bottom. To reduce the resistance of the solution, it is common practice to add an indifferent electrolyte which will not affect the results. This is frequently 0.2 *N* KCl. The current which flows through the solution is measured by means of a highly sensitive galvanometer. As the voltage is increased, the reading on the galvanometer increases uniformly until a point is reached at which the

reduction of a particular ion takes place. At this potential, the current will increase abruptly and will have a definite increment, depending upon the concentration of the electro-reducible ions. Fig. 4 illustrates this phenomenon and shows the relationship between applied voltage and galvanometer readings for a solution containing lead. The potential, referred to a normal calomel electrode (N. C. E.) at which the increase in current passes the inflection point, known as the half-wave potential, is different for each metallic ion. The potentials follow closely the familiar electro-chemical series. By

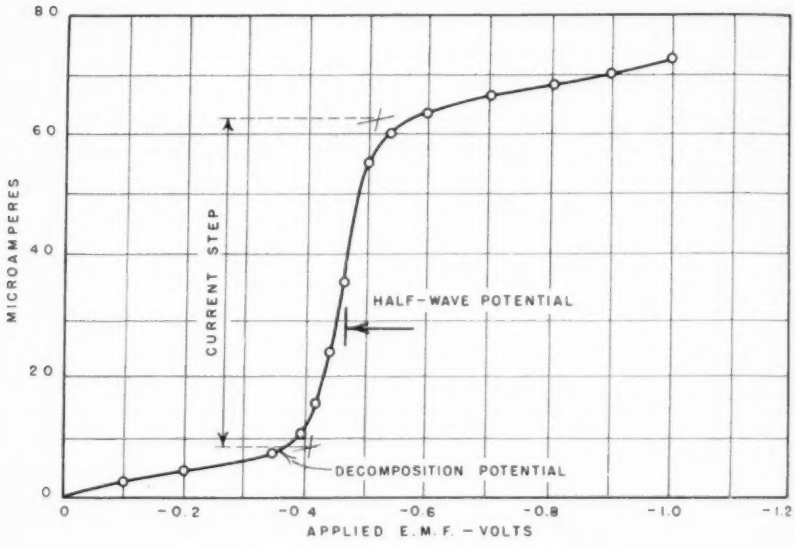

FIG. 4. Polarogram of $PbSO_4$ in 0.1 *N* KCl

mathematical analysis it may be proved that the height of the current increment, or the current step, is directly proportional to the concentration of the metal in solution. Experimental data will also verify this direct proportionality, as may be noted in Fig. 5, which shows the relationship between voltage and current step for various concentrations of lead. This straight line variation greatly facilitates interpretation of the analyses. The slope of the line will vary with certain factors, such as temperature, rate of drop formation, pH, the size of capillary, the formation of complex ions, and others, all of which can be controlled during any series of experiments.

Certain substances will interfere with the current-voltage curves. The ion or other substance being determined must be in a definite ionic or molecular form in the solution. Other reduction or precipitation reactions may obscure the current step if they are occurring simultaneously. Means are available for eliminating these simultaneous reactions by controlling or adjusting some of the variable factors. Adsorption or catalysis phenomena may give abrupt rises, knows as "maxima," in the current voltage curve. The discharge of hydrogen, or the reduction of oxygen, may also bring about the pres-

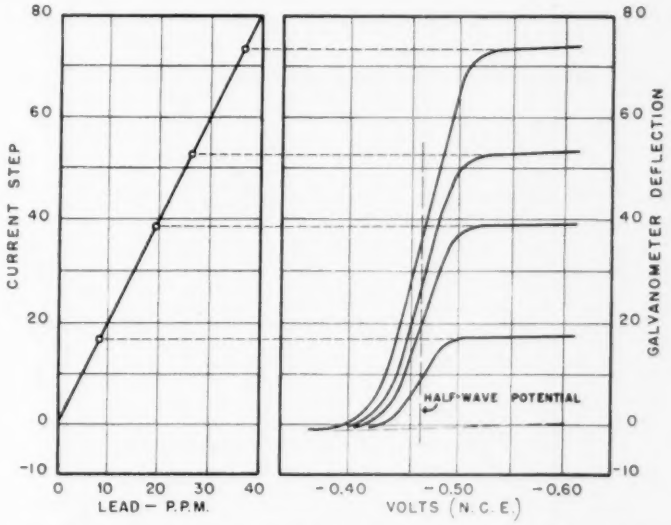

FIG. 5. Relationship of Current Step and Concentration of Lead, as determined by current-voltage polarograms

ence of maxima, the elimination of which may be accomplished by the addition of surface active substances in minute quantities. Dyes, fatty acids, gelatin, starch, organic soaps, alkaloids, and other compounds may be used as suppression agents in the solution.

Oxygen must be removed from the solution by bubbling nitrogen or hydrogen gas through it before making the polarographic analysis. As a matter of fact, this method of analysis may readily be applied to the measurement of the concentration of dissolved oxygen in a solution (9). The relation between current and oxygen content of a series of solutions is given in Fig. 6.

Application of Polarographic Method

The sensitivity of the polarographic method of analysis for qualitative identification of substances is on the order of 10^{-5}, or one hundred millionth of a gram. In quantitative analysis, a dilution of 10^{-5} or 10^{-6} N may be determined fairly accurately. Relatively dilute solutions are desirable for accurate determinations, since large diffusion currents and low sensitivity ratios of the galvanometer prevail at high

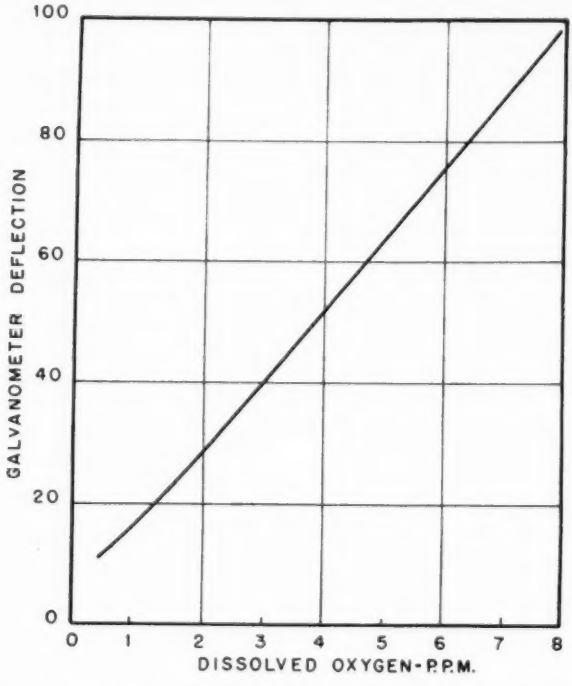

FIG. 6. Relationship Between Concentration of Dissolved Oxygen and Galvanometer Deflection

concentrations and tend to reduce the accuracy of measurement. Therefore, it is advisable to dilute samples appearing in large concentration, in order to make accurate determinations. In like manner, for extremely dilute solutions, where evaporation does not affect the constituents, it is possible to concentrate the solutions in order to bring them within the range of sensitivity for quantitative determinations on the instrument.

Since all metals have a different reduction potential, this method of analysis may be applied for the simultaneous determination of a number of metals in solution. A curve showing the current-voltage characteristics of a solution containing copper, lead, cadmium, zinc and iron is shown in Fig. 7. Knowing the position on the voltage scale with reference to a N. C. E. of each of the abrupt changes of the current, the identification of the ion associated with each current step may be made. Furthermore, by measuring the increment of the current step at each potential, the concentration of each metallic ion may be determined from the curve, once the calibration has been made.

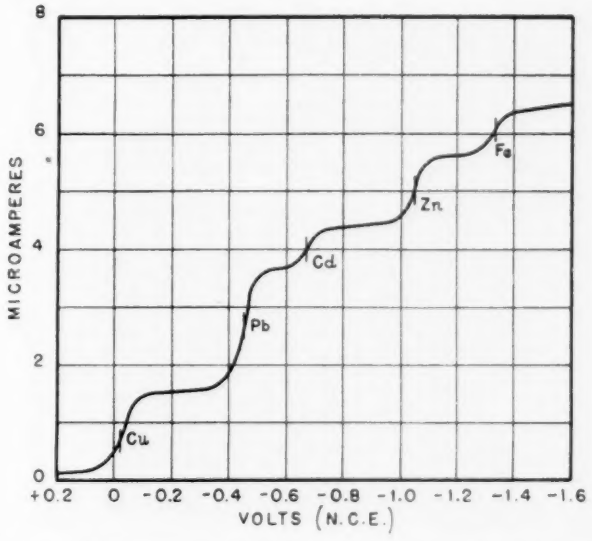

FIG. 7. Relationship Between Current and Volts With Various Metals in Solution

In the example noted above, the dropping mercury electrode was made cathodic in the electrical circuit. By using the dropping electrode as an anode, investigations of electro-oxidizable substances may be carried out. This procedure is limited to those reactions whose oxidation potential is lower than the oxidation potential of mercury. By this method it is possible to determine the concentrations of such anions as chlorides, bromides, nitrites, nitrates, etc. Techniques have also been developed for the determination of many organic radicals and compounds.

In this grounding research, it will be desirable to measure only one or possibly two ions in the water coming from some of the pipes. For this purpose, it is not necessary to make the complete run over the entire voltage range. It has been shown (10) that by measuring the increment in current produced by the application of two voltages equally spaced about the half-wave potential, one below and one above, the increments of current are directly proportional to the

FIG. 8. Elecdropode—Fisher Scientific Co.

concentration. By the addition of a reference or "pilot" ion of known concentration, such as thallium, a substance which, in all probability, would not be present in the solution to be analyzed, the concentration of the unknown ion may be determined from the ratio of the increment of the pilot ion to that of the unknown. The ratio remains a straight-line relation between concentration and the current step.

Apparatus Available

A number of instruments which may be utilized for this analysis are available on the market. The essential circuit is shown in Fig. 4.

It consists of a battery as a source of potential, a variable resistance, and a sensitive galvanometer equipped with a variable shunt. Figure 8 shows an instrument equipped with the dropping mercury electrode mounted on the panel and the reservoir of mercury clamped above. Switches are provided for various voltage ranges and settings for calibration, as well as for varying the resistance of the galvanometer shunt to change the sensitivity of the instrument. The potential is changed by moving the dial calibrated in hundredths of a volt. The current is read on a translucent scale by means of illuminated galvanometer mirrors. The instrument is manually oper-

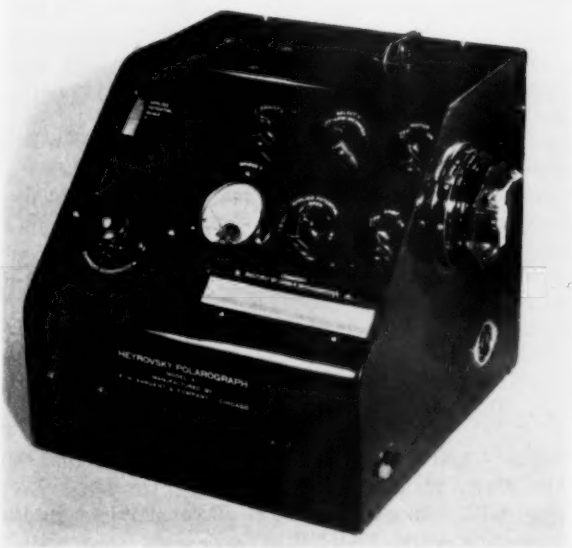

FIG. 9. Heyrovsky Polarograph—E. H. Sargent & Co.

ated and readings are usually plotted during the course of the measurements to observe the current-voltage curve and thus to check any discrepancies which might occur.

A further refinement in instrumentation is shown in Fig. 9. This is known as the "Heyrovsky Polarograph," which provides for recording the current-voltage curve automatically. A focused beam of light reflected from a mirror galvanometer strikes a sensitized paper driven by a motor and drum. Constantly increasing potentials are applied to the system by means of a motor-driven voltage divider, coupled to the drum so that the voltage is proportional to the move-

ments of the paper, on which co-ordinates are flashed by the machine. This instrument automatically records the current throughout the entire voltage range. The photographic record is then developed and analyzed for the identification and measurement of concentrations of the substances present. A visual scale is also provided for observations during the course of any one run. The operation of the entire process is completely automatic.

The simplicity and speed of operation, accuracy of results, and ability to include all metals in one analysis, render this method the most suitable one for the purpose of determining the metallic ions present in the water entering and leaving the pipe used in this grounding research.

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Experimental Studies of Tank Coating Materials

By J. O. Jackson

IN 1931 the Pittsburgh-Des Moines Steel Company, in co-operation with the Borough of Ambridge, Pa., conducted a rather extensive test of paints for water tank interiors. Gratifying results from this test have indicated the necessity of testing paint for the exteriors of steel structures. Much has appeared in the technical papers of the past ten years regarding various types of paints, various chemical treatments of steel, and new methods of mill scale removal. It is hoped that this and other contemporary tests will contribute to a more scientific knowledge of the protection of exposed steel surfaces and that immediate results in more effective paint materials will be forthcoming.

This paper consists of a report of the experimental work and research in methods of cleaning steel preparatory to painting, in methods of treating steel surfaces chemically to inhibit corrosion, and on the life of paint coatings as determined by exposure tests and surveys of actual field life on a great many elevated tanks and standpipes during the last six years. It is confidently believed that if the recommendations herein are followed, a more satisfactory paint protection for steel tank structures will be obtained.

The subject divides itself naturally into four principal parts—cleaning, surface treatment, the protection of inside tank surfaces, and the protection of outside tank surfaces—which will be discussed in that order.

When steel is shipped from the rolling mill it has a tightly adhering coating of iron oxide, usually blue, but sometimes reddish, in color. If the steel is kept in stock for any length of time at the fabricating shop, particularly if it is kept outdoors, this blue surface, which is

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A paper presented on June 24, 1941, at the Toronto Convention by J. O. Jackson, Manager, Engineering and Purchasing Departments, Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

called mill scale, will begin to fail by the formation of occasional rust spots. After a few months, a part of the scale will have become loosened and the steel surface, where it has fallen away will be completely covered with rust. If the steel is allowed to remain outdoors unprotected for long periods of time, the general surface rusting will continue and, in addition, will become accelerated at certain places over the surface, resulting in pitting. The volume of the rust which forms is many times the volume of the original piece of steel and usually much less of the metal is consumed than might be judged from the thickness of the rust on the surface.

The fabricating shop, therefore, is confronted with three types of surfaces: (1) the clean tightly adhering mill scale; (2) the cracked and broken mill scale on newly rolled steel which is bent or formed in

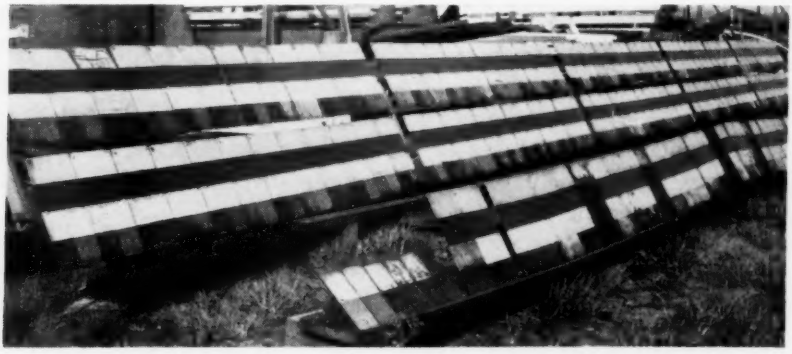

FIG. 1. Paint test fence; showing comparative effects of exposure

fabrication in such a way that the surface of the mill scale is cracked; and (3) partially weathered steel in which the mill scale is more or less completely loosened and removed by the action of weathering.

Tests of Paint Life

In order to evaluate the paint life on these three types of surfaces an exposure test was started in September, 1939, using 164 different steel primers applied to steel panels 11 in. in width by 22 in. in height. Half of each panel, $5\frac{1}{2}$ in. x 22 in. in size, was sandblasted, removing all mill scale, and on the other half the scale was left intact. The painted panels were then mounted on a test fence (Fig. 1) inclined 60 degrees from the horizontal and facing a southerly direction. The primers were allowed to weather for a period of six months, approximately

the time required to ship and erect the steel structures. The plates were then divided into four horizontal zones, the lowest zone remaining untouched so as to expose the primer only, the second being painted with a spar varnish aluminum field coat, the third with a carbon black synthetic vehicle finish coat and the fourth or top zone with a synthetic aluminum paint, which three types of paint are believed to represent the most common field coats for steel structures.

A second set of steel panels, 24 in. square, was treated by the various chemical or mechanical treatments for the removal of mill scale or for the chemical inhibition of corrosion, then painted with primers which had in the past been found effective. Later these panels also were divided into four horizontal zones and painted as described above. An inspection on May 4, 1941, after approximately 584 days' exposure of the primers, and 410 days' exposure of the field coats, revealed the results shown in Table 1.

It will be noted from this table that the percentage of failure of the paints over sandblasted surfaces is approximately the same as over mill scale surfaces, while the surfaces which were weathered before painting show a very much greater percentage of failures.

Cleaning Methods

Wirebrushing consists of rubbing the steel surface either by hand or with a rotary power tool, using a wire brush. For power wirebrushing a brush with long flexible bristles operated at a high speed is more effective than a brush with short stiff bristles.

Flame cleaning consists of going over the surface of the steel with a multi-flame torch using oxygen and a fuel gas, usually acetylene, so that the surface of the steel is heated very rapidly causing a portion of the mill scale to crack off, destroying any combustible foreign materials on the steel surface, and warming and dehydrating the steel surface, thus providing a very satisfactory surface for the application of paint.

Sand or shot blasting consists of cleaning or abrading the surface, using sand or shot grains projected against it at high velocity by means of a jet of compressed air. The mill scale may be entirely removed by this method.

Pickling consists of removing the mill scale by immersing the steel in a hot solution of from 5 to 10 per cent sulfuric acid in water, preferably using an inhibitor to prevent the acid from removing too much

TABLE 1

Analysis of Failure of Primer after 584 Days Exposure and of Three Different Second Coats after 410 Days Exposure with Different Treatments

TREATMENT	NO. OF PANELS	PRIMER FAILED		SPAR VARNISH ALUMINUM—FAILED		SYNTHETIC VEHICLE BLACK—FAILED		SYNTHETIC VEHICLE ALUMINUM—FAILED	
		No.	%	No.	%	No.	%	No.	%
Primers on sandblasted surfaces	164	146	89	32	21	26	16	22	13
Primers on mill surfaces	164	149	91	32	19	20	12	18	11
Panels pickled and given Chemical Treatment TR1	6								
Weathered 6 mo., no primer	1	—	—	0	0	0	0	0	0
Weathered 6 mo., primed	5	5	100	0	0	0	0	0	0
Panels not pickled but given Chemical Treatment TR1	4								
Weathered 6 mo., no primer	1	—	—	1	100	1	100	1	100
Weathered 6 mo., primed	3	3	100	1	33	2	67	2	67
Panels pickled and given Chemical Treatment TR2	6								
Weathered 6 mo., no primer	1	—	—	1	100	1	100	1	100
Weathered 6 mo., primed	5	5	100	1	20	0	0	0	0
Panels not pickled but given Chemical Treatment TR2	4								
Weathered 6 mo., no primer	1	—	—	1	100	1	100	1	100
Weathered 6 mo., primed	3	3	100	3	100	2	67	2	67

TABLE 1—*Concluded*

TREATMENT	NO. OF PANELS	PRIMER FAILED		SPAR VARNISH ALUMINUM—FAILED		SYNTHETIC VEHICLE BLACK—FAILED		SYNTHETIC VEHICLE ALUMINUM—FAILED	
		No.	%	No.	%	No.	%	No.	%
Panels pickled and given Chemical Treatment TR3	6								
Weathered 6 mo., no primer	1	—	—	1	100	1	100	1	100
Weathered 6 mo., primed	5	2	40	1	20	0	0	1	20
Panels flame descaled—1 pass	10								
Weathered 6 mo., then primed	5	5	100	5	100	5	100	4	80
Primed immediately	5	5	100	2	40	3	60	3	60
Panels flame descaled—3 passes	10								
Weathered 6 mo., then primed	5	5	100	5	100	5	100	4	80
Primed immediately	5	5	100	2	40	1	20	1	20
Panels pickled	10								
Weathered 2 mo., then primed	5	5	100	5	100	4	80	5	100
Primed immediately	5	5	100	3	60	2	40	2	40
Panels given Chemical Treatment TR6	6								
Primed and given field coat	4	Covered		—	—	2	50	2	50
Primed only	2	2	100	—	—	—	—	—	—

of the steel after the scale has been removed. After pickling, the steel is washed with hot water and dipped into a neutralizing lime bath.

Weathering consists of erecting the steel tanks, omitting any shop or field coat of paint and allowing the action of the weather to start a corrosion which gradually loosens and removes the mill scale.

From the observations in this part of the test it was concluded that all foreign substances should be cleaned from steel surfaces to be

painted. If the steel has a clean, thin, unbroken tightly adhering mill scale, however, that need not be removed; but if the mill scale is cracked or broken during fabrication it should be removed either by sand or shot blasting, by pickling, or by flame cleaning followed by power wirebrushing. If the mill scale is removed by flame cleaning the surface should be painted while the steel is still warm; if removed by sand or shot blasting the surface should be painted before any rusting occurs; and if the scale is removed by pickling, the pickling acid should be completely neutralized, and the primer applied as soon as the plate is dry and while it is still warm.

In the case of weathered steel or in the case of old work where the steel is entirely or partially covered with rust, all rust, down to clean bright metal, should be removed by sand or shot blasting or by flame cleaning and power wirebrushing.

Chemical Treatment

The chemical treatment of steel surfaces has as its object the formation of a new substance, which is less corrosive than bare steel, on the surface of the steel, and the formation of a roughened surface which will provide a better bond for the paint coat. Phosphoric acid is the active chemical usually used in this treatment.

Table 2 shows the relative life to be expected from surfaces which have been treated chemically as compared with mill scale, sand-blasted or flame-cleaned surfaces. It will be noted that after 584 days' exposure the surfaces which were pickled and Parkerized were all in satisfactory condition. It should also be noted that surfaces treated chemically over mill scale are unsatisfactory. Mention should be made of the fact that in this test the surfaces which were flame cleaned were not painted immediately after flame cleaning while the steel was still warm. It was not appreciated when the test was started that this procedure produced better results. It is believed that the results for the flame cleaned panels which were not weathered would have been better if the paint had been applied immediately, while the steel was still warm.

Chemical treatment is recommended for maximum paint life. Complete removal of the mill scale by pickling is imperative. It is questionable whether the increased cost of pickling and chemical treatment is justified by the slight increase of life over unbroken tightly adhering mill scale surfaces or surfaces flame cleaned or sand or shot blasted.

Protection of Inside Tank Surfaces

There is a considerable variation in the effect of waters of different localities on paint and coatings used in the interiors of tanks. Instances have occurred where certain paints which are satisfactory in one locality have been removed completely or dissolved by the water of another locality within a period of only a few months. Certain paints or coatings have, however, been very satisfactory, holding up for several years with practically no sign of failure when used in certain localities. It appears to be very difficult, if not impossible, to

TABLE 2

Results after 584 Days Exposure

TREATMENT	NO. OF PANELS	PERCENTAGE OF PANELS STILL SATISFACTORY
Pickled and Parkerized	5	100
Pickled and Bonderized	5	93
Pickled and Granadized	5	87
Mill scale left on	164	86
Sandblasted	164	83
Flame cleaned; 3 passes; not weathered	5	73
Pickled only; not weathered	5	53
Not pickled and Durized	4	50
Flame cleaned; 1 pass; not weathered	5	47
Not pickled and Parkerized	3	44
Not pickled and Bonderized	3	22
Pickled only; weathered	5	7
Flame cleaned; 1 pass; weathered	5	7
Flame cleaned; 3 passes; weathered	5	7

predict from the chemical analysis of the water to be stored what type of paint or coating will give satisfactory service, the only reliable indication being the results from the results from an actual immersion test.

The names of the ten paints and coatings which have been found to give the most satisfactory service in actual use are given below. Some of them are adapted to certain types of stored water but none of them appears to be suitable for use with all types. It is recommended that, unless certain paints have been found to be satisfactory for any given locality, the inside surface of the tank be divided into ten vertical strips, each strip being painted with one of the

above materials, starting preferably at the tank manhole or ladder and that an accurate record of the location of the paint and the effect of the water on the various panels be kept by making periodic inspections. It is believed that if this procedure is followed it will be found that one of the materials will be found suitable in almost every instance. The cost of the initial painting is not very greatly increased in making the above test and the cost of subsequent maintenance may be considerably reduced because of it.

The paints suggested for such use are as follows:

Inhibitive Primer

The Glidden Co., Cleveland, Ohio, No. 1525 Chromate Primer used under paints rating 100 per cent in both Ambridge and Mahoning Valley tests.

Top Coats

1. Two coats of Glidden No. S1777 Interior Bakelite Tank Enamel. Rated 100 per cent in Ambridge and 75 per cent in Mahoning Valley test.

2. Two coats of Asphalt Varnish per U. S. Government Specification No. TT-V-51. Rated 15 per cent in Ambridge test.

3. Substitute for the above primer the following red lead and litharge paints:

COMPOSITION OF PAINT	PER CENT BY WEIGHT		
	First coat	Second coat	Third coat
1. Red lead	73.30	72.43	68.74
2. Litharge	6.57	6.84	8.07
3. Lampblack	None	.32	1.26
4. Raw linseed oil	17.73	18.09	19.50
5. Turpentine	1.48	1.54	1.50
6. Liquid drier	.92	.78	.93
Total	100.00	100.00	100.00

These paints are the standard adopted in 1930 by the New England Water Works Association (Jour. A.W.W.A., **23**: 2162 (1931)).

4. Two coats of Ault & Wiborg No. 3546-A for brushing or 3546-B for spraying, Aluminum Protektol. Rated 92 per cent in Ambridge test and 60 per cent in Mahoning Valley test.

5. Two coats of Socony Paint Co. 29-D-100 Interior Tank Paint. Rated 95 per cent in Mahoning Valley test.

6. Two coats of Pratt and Lambert Aluminum Interior Tank Paint. Rated 100 per cent in Mahoning Valley test.

7. Two coats Hill-Hubbell Biturine Aquakote. Rated 100 per cent in Mahoning Valley test.

8. Substitute for above primer "Tornesite" Interior Tank Paint made by the Pennsylvania Salt Mfg. Co. Rated 100 per cent in Mahoning Valley test.

9. Substitute for above phosphoric acid pre-treatment followed by International Rustproof Corp. #178 Rustarest Primer followed by one coat #147 Rustarest Paint with $1\frac{1}{2}$ lb. aluminum per gallon. Rated 100 per cent in Mahoning Valley test.

10. Substitute for above primer one coat Dearborn Chemical Co. No-Oxide Water Works Coating applied cold $\frac{1}{16}$ in. thick. Rated 90 per cent in Mahoning Valley test.

The above list does not include hot applied coatings because of the special equipment required. If it is desired to include hot coatings, the following are recommended for trial:

1. 1 coat Bitumastic Solution followed by 1 coat Hot Bitumastic Enamel either soft, medium, or hard glossy grades, made and applied by Wailes-Dove Hermiston Co. Rated 100 per cent in Mahoning Valley test.

2. 1 coat Bituminous Solution and one coat of Bituminous Enamel made and applied by the Briggs Bitumen Co. Rated 95 per cent in Mahoning Valley test.

3. 1 coat Bitumastic Solution and 1 coat of Bitumastic Water Works Enamel made and applied by the Barrett Co. Rated 100 per cent in Mahoning Valley test.

4. 1 coat Bituminous Solution and 1 coat of Aqualine Bitumastic Enamel made and applied by Hill, Hubbell & Co. Rated 100 per cent in Mahoning Valley test.

5. 1 coat Asphalt Cutback Primer and 1 coat of 180° Asphalt made by the Standard Oil Co. of Ohio. Rated 100 per cent in Mahoning Valley test.

Within the last several years cathodic protection has come into increased use. A survey of the elevated tanks and standpipes completed within the past six years indicates that cathodic protection has been installed in about 8.7 per cent of all tanks built. The own-

ers report that complete satisfaction has been had in 73 per cent of the installations, that 13 per cent have been unsatisfactory and that 14 per cent are questionable. The most common reason given for the unsatisfactory installations is the effect of ice on the cathodes, particularly in the northern localities.

Another method of protecting tank interiors is the use of sprayed coatings of non-rusting metals, such as zinc. This method produces excellent results but the cost is excessive. Cement coating of interior surfaces has also given very favorable results.

It is recommended that preference be given to the cathodic method of protecting interior tank surfaces. For this purpose it is recommended that the mill scale be removed in the shop either by pickling or sand blasting and that the inside surface be given a coat of linseed oil to protect the plates during shipment and erection. The removal of mill scale is not essential to the cathodic process but unless it is removed it comes off during the first few months of service and either piles up on the tank bottom preventing effective protection or it gets into the water mains.

If painting is to be used for the protection of inside tank surfaces, it is recommended that the paint test involving the ten recommended paints be applied in each locality until paints or coatings which will give satisfactory service in that locality have been proved.

Protection of Outside Tank Surfaces

If the outside tank surfaces are properly cleaned, as previously outlined, a satisfactory paint job is assured, providing a suitable primer and top coat are used. Listed in Table 3 are the primers which have been found by test to be the best of 164 different kinds tested. These have given satisfactory results over both sand blasted and mill scale surfaces.

After the outside surface has been properly primed the selection of a top coat depends principally on the color desired except that it must be compatible with the primer used. All of the above primers have been tested with and are known to be satisfactory for paints of either the linseed oil or synthetic resin vehicle types. Aluminum paint has been found to be somewhat more serviceable than black paint. Various shades of gray make very satisfactory tank paints, but shades of green though attractive are very susceptible to fading.

It is recommended that exterior surfaces be painted with one coat

of primer followed by two top coats of slightly contrasting color. A four-coat job will give a slightly longer life, but a still longer life will be obtained by spot coating and applying the fourth coat after about two years of service of a three-coat job.

Proper maintenance of steel tanks cannot be over-emphasized. According to the results of surveys many customers do not even inspect the interiors of their tanks for periods up to six years. It is

TABLE 3

Recommended Primers for Protection of Outside Tank Surfaces

MANUFACTURER	PAINT	COLOR
Peerless Paint Co., Pittsburgh, Pa.	Red Lead Shop Coat	Orange
Pecora Paint Co., Philadelphia, Pa.	Red Lead Primer #819	Red
John Lucas & Co., Philadelphia, Pa.	Metalife	
Grand Rapids Varnish Co., Grand Rapids, Mich.	Alkyd metal #66-027	Orange
W. W. Lawrence Paint Co., Pittsburgh, Pa.	Syn-ol Metal M 6228	Orange
Stoner Mudge, Inc. Paint Co., Pittsburgh, Pa.	S-827 Yellow	Yellow
Sterling Varnish Co., Haysville, Pa.	R-305 Gray Primer	Gray
Bakelite Corp., Bloomfield, N. J.	Corrosive primer XE-11377	Yellow
" " " " "	Corrosive Primer XE-11378	Red
" " " " "	Dispersion Resin XE-8408	Yellow
Wailes-Dove Hermiston Corp., New York, N. Y.	Bitumastic aluminum	Aluminum
M. B. Suydam Co., Pittsburgh, Pa.	#952 Primer	Red

believed that the most economical method of maintaining a steel tank is to drain and inspect it each year and to clean thoroughly any rust spots, spot-painting them each year until general failure of the paint coat. When the entire coat of old paint begins to fail it should be removed, preferably by flame cleaning followed by power wire-brushing, and the tank repainted completely in the manner recommended above.

Conclusions

The conclusions from this study were as follows:

Cleaning

On new work where the mill scale is not cracked or otherwise impaired in fabrication, cleaning by wire brushing is sufficient. On new work where the mill scale is impaired its removal is imperative, either by sand or shot blasting, pickling, or weathering, or by flame cleaning followed by power wire brushing.

On old work where the steel has become rusty, complete removal of the rust either by sand or shot blasting, or by flame cleaning followed by power wire brushing, is essential to satisfactory paint life.

Surface Treatment

For new work maximum paint life may be obtained from surfaces which are pickled and then given a phosphoric acid treatment before painting.

For old work brush applied phosphoric acid solutions appear to have a definite value.

Protection of Inside Tank Surfaces

The protection of inside tank surfaces by the cathodic method is recommended, in preference to painting. In cases where paint is desired, an experimental method is outlined for determining the proper kind of material to be used for various waters.

The Protection of Outside Tank Surfaces

A list of primers which have been found to give the longest paint life both on sandblasted and mill scale surfaces is given; and numerous top or finish paint coats are recommended as being satisfactory.

Progress in Plumbing Standardization

By M. W. Cowles

THE need for an accurate knowledge of the plumbing on customers' premises is by no means new to those who are active in the public water supply field, since the distributing pipes through which water reaches the consumer are a part of the plumbing system of a building. The degree of interest in the subject has varied greatly since 1870 or thereabouts when water was first available continuously in public mains and under adequate pressures throughout the day. As modern plumbing developed, health authorities became less concerned with plumbing and, perhaps, water purveyors less interested in water distribution piping within buildings. The so-called Hoover Plumbing Code of 1924, contained a section on water distribution piping, including cross-connections. This increased interest somewhat, but not until the amebic dysentery outbreak in Chicago in 1933, and similar types of outbreaks at other places, was real attention given to the possible contamination of water supply piping within premises from causes other than cross-connections involving a secondary source of supply.

The authors experience as a representative of the Association on one of the groups working in the field of plumbing standardization has indicated very clearly to him that there is still a serious lack of genuine understanding and co-operation on the part of water purveyors and perhaps to a lesser extent of public health authorities. Interest in the problem is not sufficient. The fundamental relationships that exist between water distribution systems in public streets and water distributing piping on customers premises are not clearly understood. Perhaps this paper may help to explain some of the more recent developments.

A paper presented on June 26, 1941, at the Toronto Convention by M. W. Cowles, Health Officer, Hackensack Water Co., New Milford, N. J.

Relation of Water Purveyors to Customers' Premises

In the question of the relation of water purveyors to customers' premises, there are many divergent points of view as to how far the water purveyor should go. Some favor absolute control over the water piping on customer's premises; others insist on as little control as possible, leaving the burden to the agency which supervises and inspects plumbing, whether in the health department or the building department. Either position may be unsound. Probably each purveyor must work out his own solution in terms of his own problems. Close co-operation with other agencies is, however, important.

Without a knowledge of current trends in plumbing in his area, a water works man cannot render adequate service. Installation of specialized equipment over large areas supplied will introduce special problems, which cannot be anticipated except through a familiarity with the plumbing changes that are taking place. The size of service laid, the size of meter, the water-using equipment, all have a bearing, negligible at first, but suddenly increasing to large proportions. Any water works man is vitally concerned with what goes inside his customers' premises. Whether or not he wishes to control the plumbing, he should, at least, know what it is.

In regard to bacterial quality of water, contamination of the water within customer's premises is a relatively new subject, except insofar as it may occur through what have always been called "cross-connections." It has been found that the presence of a vacuum or negative pressure in the water lines in a building may produce contamination of the water (1, 2). This may be very directly related to question of adequacy of service in a building. A condition of vacuum on the upper floors of a three-story building, for instance, is very frequently apt to occur where the residual pressure, with the tap open, is found to be very small. Back-siphonage may occur with improperly designed fixtures.

Customers use water delivered through a part of the plumbing, not direct from the mains. Therefore, they, too, are vitally concerned with the question of plumbing.

Problems of Plumbing Terminology

In any conference on the question of back-siphonage or plumbing hazards, there inevitably arises the question of terminology. A sub-committee of Sectional Committee A-40 of the American Stand-

ards Association (A.S.A.)[1], working on safe air-gaps, has used "back-flow connections" to include not only "cross-connections" (with a meaning substantially as defined by the Committee on Cross-Connections 7-K[2]) but also the type of plumbing hazard resulting from the creation of a vacuum, variously known as "inter-connection," "back-siphonage hazard" or "plumbing hazard." "Plumbing system"[3] as used by that committee includes the water distributing pipes and their appurtenances. Any water-borne contamination or pollution originating on a customer's premises may result from the establishment of an abnormal pressure differential in the water distributing pipes. Contamination through a cross-connection involves direct connection of pipes. Contamination through an inter-connection or back-siphonage connection is the result of some flow-controlling device or appliance attached to an outlet from the water distributing pipes. Therefore, contamination in either case comes as a direct result of work done on the plumbing system on a customer's premises. Such contamination may or may not affect the quality of the water in the street mains.

It is of interest to note that, in a bulletin issued in 1934, King and Dawson (3) used the term "indirect cross-connection" to cover any condition in a plumbing system where a safe water supply within a building could be contaminated by unusual conditions. A direct cross-connection had practically the same meaning as referred to in the preceding paragraph. In about 1935, the terms "back-siphonage," "plumbing hazard," "inter-connection," and, later, "back-

[1] The scope of Sectional Committee A-40, as redefined by the A.S.A. Standards Council, on September 20, 1934, is as follows:

"Minimum requirements for plumbing, including water supply distributing systems, drainage and venting systems, plumbing fixtures, apparatus devices; and the standardization of plumbing equipment, including materials, uniformity of roughing-in dimensions, efficiency of operation and other performance specifications."

[2] "A cross-connection may be defined as any physical connection by means of which water may flow between a public or private potable supply and a non-potable supply or an unapproved supply."

[3] "Plumbing system," as used in the proposed American Standard on Air-Gaps includes: "that portion of the water distributing piping and appurtenances thereof, in a building or on premises, which are in the ownership or under the control of the owner of the premises; the plumbing fixtures and fixture traps; the soil, waste, and vent pipes; and such portions of the house drain and house sewer as are in the ownership or under the control of the owner of the premises."

flow connection" came into more or less common use. The A.S.A. sub-committee has not attempted to apply any precise definition to this latter group of terms.

When the A.S.A. Sub-Committee No. 12 report on air-gaps was circulated, about a year ago, to more than one hundred individuals serving as either health supervisory officials, water works operators or plumbing inspectors, a variety of opinion in regard to terminology, was given. The lack of uniformity was surprising. An expression of opinion of outstanding water works operators on the question of desirable terminology was difficult to obtain, perhaps largely because these operators did not exactly understand some of the fundamentals involved.

Need for Standardization of Plumbing Fixtures

Following the Chicago epidemic of 1933, the activities of the Chicago Health Department and the master plumbers of that city, and the demonstration of the back-siphonage idea, manufacturers of plumbing fixtures attached to water distribution piping were faced with the question of re-designing their products. The problem became very acute to them, but despite their anxiety to co-operate, many of them found, after extensive changes of patterns, that, although their new products were acceptable in some areas, in others, they could not meet specifications. This indicated very clearly that, for products sold on a nation-wide basis, some further standardization was essential. Back-siphonage of plumbing devices generally results from the creation of a vacuum and very little actual laboratory or field data on the problem were available.

A group, represented by the Plumbing Fixtures Manufacturers Research Associateship, sponsored by a group of industries operating in the vitreous china, cast-iron enameled-ware and brass goods fields, arranged with the National Bureau of Standards (4, 5) to carry on some theoretical tests to determine the hydraulic principles involved. Considerable preliminary work along this line had already been done by several of the large manufacturers. At about the same time, the National Association of Master Plumbers, under the auspices of its Sanitary Committee, set up a research project at the University of Iowa under F. M. Dawson, Dean of the College of Engineering. Thus two agencies, with somewhat different fundamental viewpoints, have been working on the problem for a considerable number of years.

At the Buffalo Convention in 1937, the author, together with water works operators, health officials and others, representing several national associations having an interest in the general subject, formed a group for the discussion of the broader aspects of the problem. Greater co-ordination of activities was the primary purpose of the group.

Certain classes of indirect cross-connections or built-in cross-connections were obviously a problem that could be handled only in co-operation with the manufacturers. The author expressed the opinion at that time that the need for further study of the fundamentals of the problem was great and that some form of testing laboratory, operating on a basis of nation-wide recognition, privately supported, unbiased in its studies and reports, available too all manufacturers in the field, should ultimately be set up, so that its findings would be generally accepted by all of the groups and local officials which are concerned with the protection of potable water lines, on customer's premises, against contamination within the premises. Such an endeavor promised to be a tremendous undertaking and naturally much hesitation was shown.

Work of National Plumbing Laboratory

The National Association of Master Plumbers (N.A.M.P.) was represented in the group by several members who had been doing some progressive thinking on the whole subject, largely in connection with Dean Dawson's activities. The N.A.M.P. was very anxious to co-operate with water works and health officials for they needed their support. In the spring of 1938, then, the N.A.M.P. became impatient with the delay and set up a non-profit corporation which could undertake the establishment of such a laboratory. The original set-up was not entirely in accord with the viewpoint of some water works and health officials, even though the underlying idea seemed sound. After a long series of conferences in which the keynote was "co-operation," the National Plumbing Laboratory, on its present basis, finally came into being in November, 1938.

For the time, it was agreed that emphasis in the testing program should be confined to devices attached to potable water distributing piping. As opportunity arises, however, these activities may be expanded.

Aside from a duly constituted board of directors to take care of

finances and to appoint members of the council, formulation of operating policies, development of testing methods and standards, and passing on reports of laboratory investigations are solely the prerogative of the council. Of the twelve members of this body, eight must be men interested and active in the field of public health in a health department, active in some phase of the operation of public water supplies or engaged in the teaching of the problems of sanitation. Not over three members may be practicing plumbers; and no member can have any financial interest in the manufacture, sale or installation of plumbing equipment. This arrangement of membership requirements was set up to secure a wide representation of viewpoint and freedom from bias. All members serve without pay.

The council has published a small booklet entitled "Procedure for the Council"[4] which contains a series of statements in simple and direct language, covering the purposes and aims of the organization and many minor but important details not referred to in this paper. The actual testing work is done at the Institute of Hydraulic Research at Iowa University, under the personal direction of Dean Dawson, whose interest, personal attention and prestige in the field of hydraulic research have contributed in no small measure to the undertaking.

The results of the laboratory tests are submitted to each member of the council and a favorable vote of three-fourths of the members of the council will permit the device to be placed on an accepted list. The manufacturer is so notified and given authorization to place the seal of acceptance of the National Plumbing Laboratory on that particular product, but obviously not on other equipment which he may manufacture. There is no charge for the service.

Acceptance is divided into two grades: (1) outright or "regular" acceptance; (2) "provisional" acceptance. In general, a well-designed device containing an air gap of sufficient size would be considered as positive protection and receive regular acceptance. Some other devices, such as a back-flow preventer (vacuum breaker) of the mechanical type, might receive provisional acceptance, based largely on the fact that its ability to operate satisfactorily, over a long period of years, has not been demonstrated.

To date 51 investigations have been made by the Laboratory.

[4] This pamphlet can be secured by writing to: Secretary, National Plumbing Laboratory, 917-15th St., Northwest, Washington, D. C.

The results of the ballots for the last three are not yet available. Six devices have been given regular acceptance and 22 provisional acceptance.[5]

A.S.A. Standardization Activities

Several references have already been made to Sectional Committee A-40 of the American Standards Association,[6] under the sponsorship of the American Society of Mechanical Engineers and the American Society of Sanitary Engineering.[7] This committee was set up in 1928, under the chairmanship of W. C. Groeniger, Columbus, Ohio. Its full name is "Sectional Committee on Minimum Requirements for Plumbing and Standardization of Plumbing Equipment." Several sub-committees were set up on different phases of the work. In 1934, after a considerable period of relative inactivity, the scope of A-40 was re-defined[1] and a further effort was made toward securing activity on the part of the several sub-committees. A more detailed account of the present status of the organization and activities of the sub-committees is given in the Appendix (page 1579).

The work started by the manufacturers at the Bureau of Standards and that by the N.A.M.P. at Iowa University, and perhaps that by others, gave further stimulus to the work of A-40. In April, 1938, a new sub-committee (No. 12) was organized to study protective air gaps[8] for faucets and other similar common water outlets *for*

[5] A list of these devices is published regularly in *Plumbing and Heating Business*, 2736 Grand Central Terminal, New York, N. Y. Some thought is being given to the establishment of a mailing list for up-to-date records on approvals or withdrawals.

[6] A brief statement showing the organization and practical operation of the A.S.A. will be given in the Appendix (p. 1579).

[7] The American Society of Sanitary Engineering withdrew its sponsorship in August, 1940, leaving the American Society of Mechanical Engineers as the sole sponsor.

[8] "An air-gap in a water supply system is the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank or plumbing fixture and the flood level rim of the receptor. The air-gap required to prevent back-flow through a water supply opening (faucet or valve) under the action of atmospheric pressure and a vacuum in a water supply system, depends principally on: (1) the size of the effective opening, and (2) the distance between the end of the supply-feeding outlet (spout) and a nearby wall." From text of "Proposed American Standard on Air-Gaps in Plumbing Systems."

plumbing fixtures only, with a view to creating a standard for the purpose of preventing back-siphonage. The original personnel of the sub-committee represented in large measure, the viewpoint of the manufacturer and the plumber, or perhaps the plumbing industry would be a better term, with unfortunately little or no appreciation of the viewpoint of health supervisory officials or water purveyors. Such a condition could be expected. On A-40, the A.W.W.A. was originally represented by a person deeply interested in the details of plumbing but not in the problem of the relation of water supply quality nor of water supply problems in relation to deficiencies in current plumbing practice. Doubtless this came about as a failure on the part of the Association to recognize fully the implications and importance of plumbing and plumbing standardization in the water works field. The writer was appointed a member of Sub-Committee No. 12 in April, 1939. Thus far, the one or two representatives of the public health field, as members of this committee, have for a variety of reasons, been relatively inactive.

A majority of the active members of this sub-committee are representatives of manufacturers, who by reason of the chaotic condition of the national picture, were exceedingly anxious to have this air gap standard adopted at the earliest possible moment. They wanted action and they could not be criticized. There seemed to be very little difference of opinion between Dean Dawson of Iowa and Doctor Hunter of the National Bureau of Standards, regarding results of the fundamental or basic hydraulic or physical studies.

Air Gap Standard

The original committee work was confined entirely to safe air gaps for plumbing fixtures—faucets, bath tub fillers and some of the simpler water openings, realizing that certain plumbing fixtures, such as direct flushing valves, would require vacuum breakers. This latter phase was a part of their initial assignment. Obviously cross-connections could be prevented by an adequate air gap and gradually the air gap standard has changed from one relating solely to plumbing fixtures, to a much broader standard applicable to water distributing piping in buildings or on premises as a part of the plumbing system. Overhead feeds to all kinds of tanks for fire and process work are included.

The following statement from the proposed standard is of particular interest:

"To prevent certain types of back-flow connections, where the insertion of a suitable air gap is an effective method, the standard has been prepared, based on the application of certain physical principles to the design of plumbing fixtures and other water-connected devices and their installation in plumbing systems. It is recognized that in some cases special devices known as back-flow (back-siphonage) preventers are required. These devices are also called vacuum breakers."

The writer has observed that the wide circulation of the standard, in the form that it existed a year ago, has been effective in stimulating interest, particularly in the public health field. In the water works field, the interest is not so active. The standard is now in process of final printing for formal submission to A-40 and to the Standards Council of the A.S.A. for their approval. It will then be available for distribution.

In its present form, it is a splendid contribution to our knowledge of the subject. All who have participated directly or indirectly are entitled to great credit. In the work of this sub-committee, the attitude of the manufacturers has been exceedingly cordial and cooperative and they sincerely deserve an expression of appreciation for the vision and stimulus which they have provided.

The committee members realize that as time goes on, other items will be included and existing phraseology improved as the result of later tests, particularly on pipes over two inches in diameter.

In substance, the forthcoming standard provides for air gaps on faucets, bath tub fillers, goosenecks and other simple items based on the effective opening (roughly the internal diameter at the smallest cross-sectional area between the control valve and spout). The distance required is in excess of the theoretical value to provide a factor of safety and at the same time to permit the necessary measurements to be made in the field without recourse to test at a suitably equipped hydraulic laboratory. It is recognized that a sufficient air gap is the most positive method of prevention of back-flow. For larger piping, a safe rule is to require an air gap (above the top edge or rim of the tank or vessel) equal to twice the nominal diameter of the pipe. This value is well on the safe side and some experimental laboratory work remains to be done. Perhaps this is a task for the A.W.W.A. If a tank or vessel is supplied by more than one pipe, the air gap should be determined from the nominal size of the largest pipe.

Standard for Back-Flow Preventers

The original assignment of work to Sub-Committee No. 12, included not only the preparation of a standard for minimum air gaps but also of a standard for vacuum breakers (now called back-flow preventers). A sub-group was appointed for this purpose and its preliminary report covering two years of work was received by the sub-committee in April, 1941.

Back-flow preventers are devices to be inserted in the water supply lines to plumbing fixtures, *beyond the fixture or other control valve* and therefore *actuated each time* the control valve is opened. Their primary purpose is that of breaking or relieving any vacuum that may exist in the water supply line and thereby preventing back-flow of contaminated water into the water distribution piping.

Two types of such devices have so far been developed: (1) a device with moving parts arranged so that, when the water port is open, the air inlet port is closed and vice versa; and (2) a device built on the Venturi principle, provided with air inlet opening at a proper point, but without moving parts. Neither of these types of device is the equivalent of positive separation by an adequate air gap, but in the case of direct flushing valves (flushometers, flush valves) no other arrangement seems to be feasible at present.

In general, mechanical devices may be expected to fail, at least in part, after a number of years of service, especially where they are not inspected or supervised at frequent intervals. To date, the writer has seen no data which indicate the effective performance of such devices over a period of years. The Venturi type, without moving parts, is protected against mechanical failure but it produces an objectionable noise, with the result that the air inlet openings may be intentionally plugged in a variety of ways. The same may happen in connection with the mechanical devices, if they spit water. In the preparation of the standard, a sincere effort has been made to encourage the development of the non-mechanical types of preventers, even though the permissible water rise under a vacuum may be higher than that permitted for a mechanical type.

The standard, which it is hoped will shortly be available, refers in detail to water closet and other tanks, where standard overflows exist, i.e. where the actual maximum water level will not rise to the rim or top of the tank. Test specifications will also be included for devices of this character, based largely on the work done by Dawson

and Hunter and several of the large manufacturers in their own research laboratories.

Application of Testing Specifications

More than a year ago, a complete set of testing specifications and standards was approved by the Council of the National Plumbing Laboratory. The proposed A.S.A. Standard for back-flow preventers will also contain a set of testing specifications. Both of these sets of specifications are intended to apply to all water-connected devices attached to water distributing pipes in buildings, including not only plumbing fixtures but also feed lines to tanks and a wide variety of other devices to be attached temporarily or permanently to the water piping.

Assuming, for the purpose of illustration, that both specifications are identical in regard to back-flow preventers to be used with direct flushing valves for water-closets,[9] and that these specifications are applied in two different laboratories working independently on the same device, it is reasonable to expect that one laboratory may approve the device and the other disapprove, although both may be unbiased. Experience in the National Plumbing Laboratory has indicated that even in testing a simple type of back-flow preventer, it is necessary to have a long and extensive background of experience if a complete and thorough test is to be made. Experience is necessary to be able to anticipate whether or not the device under test will continue to function in its normal way after it has been in service for a number of years. Testing for the tensile strength of steel or other material is a simple matter, as compared with the testing of such complicated pieces of apparatus. This experience simply points to the desirability of a national laboratory whose results will be accepted by health authorities and water purveyors throughout the country.

Laboratories for testing plumbing equipment have been set up in a number of the larger cities, including New York, Detroit, Los Angeles, Minneapolis, Baltimore and Chicago. Also, there are state plumbing regulations in one form or another, based in part on the requirements of laboratory tests, in several states, including Oregon, Wisconsin, Connecticut, Louisiana, Missouri, Illinois, Minnesota, Texas, Kentucky, Massachusetts and Virginia.

[9] A close examination of the two sets of specifications would indicate some minor differences, but certainly too detailed to attempt to set forth in this paper.

As far as the author is able to determine, the attitude of the manufacturers of plumbing equipment is predicated, to a considerable extent, on the idea that, if their equipment is made to conform with the proposed A.S.A. Standard (for back-flow preventers), the equipment will pass the standardized tests. If the statement made in an earlier paragraph above is correct, they can still anticipate different results in different laboratories; and, if this is so, the present chaotic condition will not be eliminated. The educational value of the whole procedure, however, is still well worth the effort made.

Federal Specifications

In the plumbing field, specifications have, for many years, been issued by the Director of Procurement at Washington—a rather obvious development under any condition. The manufacturers must be in close touch with the needs of the Federal Government, for, doubtless, it is their largest single customer.

Section WWP-541A (IV part 5) of the Federal Standard Stock Catalog on Specifications for Plumbing Fixtures[10] was adopted March 30, 1940, to be effective not later than March 1, 1941. It supersedes an earlier edition (WWP-541) of August 1, 1933. The writer assumes that its requirements are effective for projects undertaken under Federal authority by any of the agencies of government or any of the government corporations. It may be assumed to supersede local plumbing regulations for such projects. It was prepared by the Government with the active assistance and co-operation of the Sanitary Cast-Iron Enameled Ware Association, the Vitreous China Plumbing Fixtures Association and Sanitary Brass Institute under the joint chairmanship of a man from one of the larger manufacturers.

A memorandum for these associations further points out that the use of this new specification for private work will give the consumer the same benefit and protection that the government demands, and further recommends that its contents be written into state and local plumbing codes.

In the specification, are paragraphs relating to air gaps, back-flow preventers, laboratory tests on a wide variety of materials, drinking fountains and many of the more common plumbing fixtures. The material on air gaps, back-flow preventers and ball-cocks for closet tanks follows more or less directly the earlier versions of the two pro-

[10] These specifications can be obtained by writing to: Superintendent of Documents, Washington, D. C.

posed A.S.A. standards based on the limited applicability to plumbing fixtures.

In connection with back-flow preventers, the allowable water rise is restricted to one inch. This can be met only by the mechanical type of preventer. The non-mechanical or Venturi type, which requires several inches, is excluded.

The Federal Government, through what is now the National Bureau of Standards, for several years has been issuing specifications for various materials used in connection with plumbing systems and also for certain types of plumbing fixtures. An example of the first type of specification is a tentative commercial standard for lead traps and bends—TS-2980, December 4, 1940. This draft was prepared by the Lead Industries Association. Apparently it will ultimately be issued as one of the Commercial Standard (CS) Series, as, for instance, was Commercial Standard CS20-36 on Staple Vitreous China Plumbing Fixtures in 1936.

The A.W.W.A. has had no representation on any of the groups working on these Federal standards or specifications. It is also of interest to note that Sub-Committee No. 2 of A-40 played no part in connection with the preparation of Commercial Standards CS20-36 on Vitreous China Plumbing Fixtures.

Standardization of Plumbing Codes

Ever since Herbert Hoover was Secretary of Commerce, efforts have been made toward standardization of plumbing codes. In 1934, the work on standardization of plumbing and other codes which had been carried on by the Secretary of Commerce was formally transferred to the A.S.A. and, in turn, Sectional Committee A-40 was given the duty of working on a national plumbing code. Not too much progress has been made by Sub-Committee No. 1 of that organization.[11]

The N.A.M.P. has published a suggested uniform plumbing code and several of the states have codes or have made specific recommendations along this line. Most of the state plumbing codes consist of a series of minimum requirements covering some of the more essential features of plumbing, leaving the details to be worked out by the individual municipalities as they see fit.

[11] For present status of this committee see Appendix (p. 1579).

The Pacific Coast Plumbing Inspectors Association has done a great deal of excellent work along this line. Its recommended code is kept as nearly up to date as possible in view of the rapid changes in the field of plumbing.

The Federal Government has recently issued a recommended plumbing code known as B.M.S. 66, prepared primarily for the purpose of serving as a guide for Federal construction in connection with national defense, including emergency housing. In many parts of the country, the requirements of the Federal Government are in substantial variation with the requirements of local codes and much friction has resulted.

If the installation of all faucets with proper air gaps and the approval of all other water-connected devices by a national laboratory can be stimulated, the question of the wording of plumbing codes becomes relatively unimportant. Code requirements that are necessary and essential to prevent the establishment of new back-flow connections in new construction either as cross-connections or interconnections are of primary interest. Such requirements must be up-to-date, for the developments in the field are rapid. Water works men must keep in touch with what is going on in the Nation and in their own territory regarding these matters.

Summary

All who are concerned with the installation of plumbing, with emphasis on water-supplied devices, should co-operate to prevent the further installation of new back-flow connections, either by the manufacturer, the person who makes the installation, the plumbing inspector or the water purveyor himself. Every water works operator is in a position to be helpful to health officials and plumbing inspectors by reason of his familiarity with the elementary principles of hydraulics that are involved in the creation of pressure differences that, in turn, make possible the flow of polluted water into water distribution piping through cross-connections or inter-connections. Increasing co-operation between these agencies, of necessity, will produce an increased appreciation of the various complex viewpoints involved. It should lead directly to the installation of water distribution piping, including fixtures and other water-connected devices, that will, by virtue of proper construction, reduce back-siphonage or contamination hazard to the lowest possible degree. It should be possible to erect new buildings that are reasonably free from the hazards of back-siphonage.

Great progress has been made in plumbing standardization during the past few years, especially along the lines of fundamental studies of vacuum production and methods of breaking the vacuum. The preparation of suitable standards applicable to the simpler water outlets for wash basins, lavatories, bath tubs and the like, and for the testing of back-flow preventers has gone forward. Finally, the establishment of a national testing laboratory has been accomplished.

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Appendix

Organization and Membership of Sectional Committee A-40 on Minimum Requirements for Plumbing and Standardization of Plumbing Equipment[12]

Chairman: (No chairman acting as of July 1, 1941.)
Acting Secretary: C. B. LEPAGE

Membership[13]*—Co-operating Organizations:*

American Society of Mechanical Engineers
American Ceramic Society
American Iron & Steel Institute

[12] As of July 19, 1941.
[13] There are 13 members-at-large, including all sub-committee chairmen.

American Home Economics Association
American Hospital Association
American Hotel Association of the U. S. and Canada
American Institute of Architects
American Planning & Civic Association
American Society of Civil Engineers
American Water Works Association
Cast-Iron Soil Pipe Association
Cleveland Engineering Society
Conference of State and Provincial Health Authorities of North America
Conference of State Sanitary Engineers
Lead Industries Association
Manufacturers Standardization Society of the Valve and Fitting Industry
National Association of Building Owners and Managers
Pacific Coast Plumbing Inspection Association
National Slate Association
The Real Estate Board of New York, Inc.—Management Division
Sanitary Brass Institute
Sanitary Cast-Iron Enameled Ware Association
Society of Naval Architects and Marine Engineers
Tubular Plumbing Goods Institute
Vitreous China Plumbing Fixtures Association
U. S. Department of Commerce, National Bureau of Standards
U. S. Navy Department
U. S. Public Health Service
Wrought-Iron Pipe Association

Sub-Committee No. 1—Code of Minimum Requirements for Plumbing

Chairman: THEODORE I. COE
Secretary: W. C. THOMPSON

Committee re-organized November 2, 1939, in an effort to broaden representation. Committee relatively inactive until April, 1941, when the above officers were elected and a definite program of work laid out, including appointment by Chairman Coe of a sub-group under the chairmanship of A. H. Morgan.

Sub-Committee No. 2—Staple Vitreous China Plumbing Fixtures[14, 15]

Chairman: H. R. VAN SCIVER
Secretary: BENJAMIN CADBURY

This committee co-operated with the National Bureau of Standards in connection with preliminary consideration of Commercial Standard C.S. 20–36 on staple Vitreous China Plumbing Fixtures, as issued by the Bureau of Standards in 1936. The committee intended to add some performance specifications.

Sub-Committee No. 3—Staple Porcelain (all clay) Plumbing Equipment[15]

Chairman: E. S. AITKIN

This committee co-operated in the preparation of Commercial Standard C.S. 4–29 on Staple Porcelain (all clay) Plumbing Fixtures as issued by the National Bureau of Standards in 1929. The committee is now inactive.

Sub-Committee No. 4—Enameled Sanitary Ware[15]

Chairman: A. H. CLINE

There is some activity on the part of this committee, but no proposed standard has been presented to Committee A-40.

Sub-Committee No. 5—Traps

Chairman: A. R. MCGONEGAL
Secretary: GEORGE W. MARTIN

This committee has prepared several drafts of a proposed standard for traps for use with plumbing fixtures. As far as can be determined, this material has not yet been submitted to the sub-committee and, therefore, has not been presented to Committee A-40.

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[14] Includes one sub-group, on back-siphonage.

[15] Sub-Committees No. 2, 3 and 4 are regarded as standing committees of the Division of Trade Standards in the National Bureau of Standards, under the direction of Iler J. Fairchild, Chief of the Division of Trade Standards. As far as A-40 is concerned, the present status of these three sub-committees is somewhat uncertain.

Sub-Committee No. 6—Standardization of Brass Plumbing Products

Chairman: J. L. MURPHY

The original sub-committee was divided into six sub-groups, but, during its reorganization the titles of the sub-groups have been changed. Sub-Group 5 on Shower Heads, Diameter, Connection and Size has completed a report. Another sub-group on minimum chemical and physical properties of brass alloys was given considerable attention and a tentative report is apparently available. This sub-group has given some thought to the question of composition of corporation cocks or types and other items of water works brass goods. No proposed standard has been prepared for circulation.

Sub-Committee No. 7—Brass Fittings for Flared Copper Tubes

Chairman: F. L. RIGGIN
Secretary: EDWARD S. CORNELL, JR.

A proposed standard (A-40.2–1936) was completed by this sub-committee, approved by Committee A-40 and issued by the A.S.A. in January, 1936 (available at 35 cents per copy from A.S.A.). No recommendations for changes in this standard have as yet been made to Committee A-40.

Sub-Committee No. 8—Cast-Iron Soil Pipe and Fittings[16]

Chairman: ———
Secretary: FRANK R. MCCARRON

A proposed standard (A-40.1—1935) was completed by this sub-committee, approved by Committee A-40 and issued by the A.S.A. in October, 1935 (available at 65 cents per copy from A.S.A.).

Sub-Committee No. 9—Gasoline, Oil and Grease Separators

Chairman: ———
Secretary: WALTER G. DOHERTY

In 1939 several drafts of a proposed standard were prepared and distributed to members of the committee. No recent report on this activity has been received by Committee A-40.

[16] Includes four sub-groups: Nomenclature; Material, Working and Inspection; Dimensions; and Promulgation.

Sub-Committee No. 10—Threaded Cast-Iron Pipe and Fittings for Drainage Vent and Waste Services

Chairman: F. HUGH MOREHEAD
Secretary: A. W. CLAUSSEN

Work on the standardization of threaded cast-iron pipe was begun by one of the federal specification committees in co-operation with the National Bureau of Standards. Subsequently Committee A-40 became interested in the subject and appointed a joint committee, composed of representatives of A.S.A. Sectional Committee on Specifications for Cast-Iron Pipe and Special Castings—A-21—and the sub-committee. The present sponsors of this joint committee are: American Gas Association, American Society of Mechanical Engineers, American Society for Testing Materials, American Water Works Association and New England Water Works Association.

At the initial meeting of the joint committee, in December, 1939, it was decided that two distinct standards for cast-iron pipe should be prepared—one for pipe for drainage vent and waste purposes and the other for pipe for pressure purposes.

In March, 1941, the joint committee issued a tentative standard (dated January, 1941) for the use of cast-iron pipe for drainage vent and waste purposes. (Copies are available from the A.S.M.E.) As this draft has been submitted primarily for comment, the material will, at a later date, after consideration of comments, become an American Standard.

Sub-Committee No. 11—Soldered Joint Fittings (for copper tubing)

Chairman: ARTHUR M. HOUSER
Secretary: EDWARD L. PENFRASE

Based on work done at the National Bureau of Standards (see report of Sub-Committee on Research in Plumbing, below), a standard (A-40.3—1941) was prepared, submitted to Committee A-40, and issued in January, 1941, as an American Standard (available at 45 cents from A.S.A.). This standard is based on the use of soft 50–50 tin-lead solder. When the results of further tests on other solders, useful for higher pressures and temperatures, are available, it is expected that the standard will be revised.

Sub-Committee No. 12—Minimum Air Gaps in Plumbing Systems

Chairman: W. K. McAfee
Secretary: M. W. Cowles

As stated in the text, a standard on minimum air gaps has been approved by the sub-committee to be submitted to Committee A-40 by ballot and then submitted to the A.S.A. for issue as an American Standard. The sub-committee has also approved a proposed standard on back-flow preventers (vacuum breakers), which will be distributed for comment and criticism prior to its submission to Committee A-40.

Sub-Committee on Research in Plumbing

Chairman: ———
Secretary: George N. Thompson

The principal function of this sub-committee has been the sponsorship of work on soldered joint fittings for copper tubing as referred to in connection with Sub-Committee No. 11. The work done at the National Bureau of Standards laboratory by A. R. Maupin, under the more or less direct sponsorship of the Copper and Brass Research Association. Other suggestions which might be useful in connection with the work of Sub-Committee No. 1 have been considered, but no work on these items is actually in progress.

Statement of Organization, Purpose and Functions of the American Standards Association[17]

The chief function of the A.S.A. is to provide an orderly and systematic method for the establishment of American Standards. A basic principle underlying all A.S.A. work is that a consensus of opinion of those having a substantial interest in the scope and purpose of a proposed standard must be reached. Representatives of manufacturers, distributors, consumers, technical specialists and others directly concerned are brought together.

A new project is taken up by the A.S.A. only upon the request of a responsible organization or group known as a "sponsor." Such a project may deal with the revision of an existing standard already in general use or it may involve development of an entirely new one. When a project has been accepted by the A.S.A. at the request of the

[17] Abstracted from A. S. A. publication PR-27 (third ed., May 10, 1940).

"sponsor," various committees to deal with the problem are set up. Each committee, through application of the principle of representation, is intended to represent a cross-section of all groups interested in the proposed standard. Such sectional committees appoint officers from their membership and sub-committees are set up (as in the case of A-40) which may in turn authorize sub-groups for the study.

If and when a sub-committee has reached agreement on a proposed standard, it is published in draft form by the sponsor and given the widest possible circulation for criticism and comment. The sub-committee then reconsiders all of this material and may revise the draft. If the sub-committee as a whole approves the changes, it then goes before the sectional committee (for example, A-40) for approval at a regular meeting or by letter ballot. In the event of an unfavorable vote, the standard is referred back to the sub-committee. In the case of a favorable vote, the proposed standard is then submitted to the sponsoring group for its approval, and in turn to the Standards Council of the A.S.A. If approved by the Standards Council the standard is published by either the A.S.A. or the sponsor.

The standards issued by the A.S.A. are available at its office at 29 West 39th Street, New York City. Price lists are available on request. If further and more detailed information is desired, a copy of the A.S.A. publication, *The Organization and Work of A.S.A. Sectional Committees*, will be sent on request.

Protection of Buffalo's Pumping Station Against Service Interruption

By Leonard A. Bergman

DURING the past year and a half, the Division of Water of the Department of Public Works of Buffalo, N. Y., has gone to considerable expense and effort to modernize its pumping facilities. Particular emphasis has been paid to making the main pump station at Porter Avenue more secure against service interruptions.

The main pump room of the Porter Avenue Station houses five triple expansion vertical steam pumps, each having a capacity of 30 m.g.d. against a head of 225 ft. and using steam at a pressure of 250 lb. These condensing engines, equipped with a water works type condenser, manufactured by the Holly Mfg. Co., were installed in 1914. In 1938 the pumping facilities were further increased by the addition of 3 motor-driven De Laval centrifugal pumps, rated at 50 m.g.d. each against 97½ lb. pressure. In this way sufficient capacity has been provided in either the steam or electrically operated units to meet the normal demand of about 150 m.g.d.

Since the installation of the electric-driven pumps, the steam pumps are retained as standby equipment and for meeting maximum demands. There are no reservoirs, pumping being directly against consumption—150 m.g.d. maximum and 90 m.g.d. minimum.

Besides these domestic pumping units, the main pump room contains three motor-driven fire pumps, having a capacity of 3,000 g.p.m. each, against 300 lb. pressure, and three steam-turbine-driven pumps of the same capacity and pressure, to supply the high pressure fire system.

Adjacent to and on the same level with the main pump room floor is the Venturi and valve room. The two rooms opened into one another through three portals in the east pump room wall. In the valve room are located 26 hydraulically operated valves in the

A paper presented on June 26, 1941, at the Toronto Convention by Leonard A. Bergman, Director of Water, Buffalo, N. Y.

discharge lines from the various pump units and from the three 60-inch mains emanating from the station.

It was obvious to those responsible for the safe and continuous operation of the plant that there were points of potential danger. Remedial measures, such as remote control of the hydraulic valves and provision of bulkhead doors, were under way when the worst catastrophe in the history of the station occurred as a result of a totally unpredictable accident.

At 1:05 A.M. on January 3, 1940, the casing of the check valve on the discharge from the center steam-driven pump failed. A piece of the casing, 2 sq.ft. in area, on the discharge side of the check blew out. The break occurred within the pump room close to the east wall. Due to many factors, such as the time of occurrence, the remoteness and, as was found, the inaccessibility of the operating valves of the hydraulic gates, it was not until 4:00 A.M. that the tremendous deluge was brought under control. The water rose in a short time to a depth of 9 ft. 5 in. above the floor of the station, putting it entirely out of commission.

The first task, of course, was to restore service. To do this the old steam standby station at Massachusetts Ave. was pressed into service. Then using diver's equipment in the manipulation of submerged valves, one by one, the steam units of the flooded station were started, and by 10:00 A.M. service was fully restored.

Subsequent to this costly experience, numerous measures to prevent or minimize the damage that would result from a similar break were taken:

1. A waterproof steel bulkhead was constructed across the main pump room, separating the steam pumps from the electric-driven units. This bulkhead divides the station into two separate and independently operated units under one roof. Any break or rupture similar to that which occurred will be localized to one of the units.

2. To limit the height of flood water in the station, a rectangular concrete overflow drain, from the station to the harbor, was constructed. Inasmuch as the main pump room floor is 8 ft. below the highest known water level in the harbor, the inlet weir of the drain was fixed at 9 ft. above the floor. The size of the drain was calculated hydraulically by assuming a back-flow of maximum proportions into the station from the distribution system. This drain limits the height of flood water in the pump room to 12 ft., the top of the bulkhead being set at 13 ft. above the floor.

3. To provide for the rapid removal of flood water below the weir level of the drain, three high capacity low lift pumps are being installed—one to be placed in the electrically operated station; one in the steam plant; and the other in the Venturi and gate room.

4. All openings in the dividing wall between the main pump room and the Venturi and gate room have been closed and three tidal gates installed. These gates allow the flow of waters from the steam pump room to the overflow drain but will prevent back-flow of flood water from the Venturi and gate room into the pump room.

5. All openings in the wall between the pump room and the areaway over the suction tunnel have been closed. This will prevent flood water from entering the suction well or the filtration plant by way of the communicating tunnel.

6. To insure a safer and quicker means of control, a completely new system for the operation of all hydraulic gate valves on the discharge lines and discharge mains within the plant has been installed. The control panel is located on the gallery of the main room near the operating engineer's post. To be assured of a pressure supply under all conditions three pressure sources are available. Over a mile of copper tubing was used in this installation. Tests of the system have shown that a 60-inch gate valve can be opened or closed in $4\frac{1}{2}$ min. The stems of the valves for the operation of the water motor vacuum pumps on all steam units have been extended above possible high water. This permits the functioning of the steam pumps even though the room is flooded.

7. Two power-driven valve operating machines mounted on trucks have also been acquired for the opening and closing of large gates on the distribution system. This now permits the isolation of the pump station, in the event of catastrophe, in 10 or 12 min. as compared to 2 hr. 15 min. by hand operation.

8. A gallery is being constructed in the Venturi and pipe room to permit convenient and periodic inspection and for the definite location of any break. In addition, new and more convenient stairs have been built from the pump room gallery to the Venturi and pipe room.

Design, computation, and plans for the modernization program above described were by the Division of Water, under the direct supervision of Louis A. Harding, Commissioner of Public Works, and the writer. Execution of the work was by contract and by W.P.A. forces.

Determination of Nitrates in Water by Modification of the Phenoldisulfonic Acid Method

By T. C. Hoppe

THE procedure for the determination of nitrate nitrogen, outlined in *Standard Methods* calls for the preparation of phenoldisulfonic acid by dissolving 25 grams of pure white phenol in 150 ml. of concentrated sulfuric acid, adding 75 ml. of fuming sulfuric, and heating for 2 hours at 100°C. A review of the bibliography in *Standard Methods* for the nitrate determination shows no modification of this procedure since 1911.

The T.V.A. Laboratory Services Staff has investigated the possibility of substituting reagent quality phenoldisulfonic acid for the laboratory prepared product and the results indicate that both reagents are equally reliable.

Following the procedure in *Standard Methods* (8th. ed., p. 48) parallel potassium nitrate standards were prepared, using the phenoldisulfonic acid as prepared in the laboratory and the phenoldisulfonic acid as purchased. The two sets of standards were read using a Cenco "Photelometer." Both sets of standards gave identical readings as shown below:

NO_3N *in mg.*	*Readings*	NO_3N *in mg.*	*Readings*
0.003	97	0.10	42
0.005	94	0.15	32
0.007	92	0.20	24
0.010	90	0.25	20
0.025	77	0.40	12
0.050	62	0.50	10

As an additional check 0.6068 gram of $NaNO_3$ was dissolved in 1 liter of water, 25 ml. of this solution evaporated to dryness, treated

A contribution by T. C. Hoppe, Laboratory Services Staff, Health and Safety Department, Tennessee Valley Authority, Chattanooga, Tenn.

as above with the purchased phenoldisulfonic acid, and diluted to 500 ml. Each milliliter of this solution then contained 0.005 mg. of nitrate nitrogen. To each of several varying quantities of this nitrate solution was added 2 ml. of KOH, and each sample made up to a volume of 50 ml.

These varying concentrations gave the following readings on the "Photelometer":

NO_3N *in mg.*	*Readings*
0.025	77
0.050	61
0.100	43
0.150	31
0.200	24
0.225	21
0.250	19

A comparison of these readings with the KNO_3 standards shows practically no deviation from the curve.

The use of the purchased product eliminates the necessity for the preparation of the phenoldisulfonic acid in the laboratory and gives results identical to those obtained by using the laboratory prepared reagent.

The above data show that the procedure for determining nitrate nitrogen could be modified and the analyst given the choice between laboratory prepared phenoldisulfonic acid and the commercially prepared reagent.

The commercial product is not a patented material. It is known to be available from at least one chemical supply house in New York and one in Chicago. Its availability in other cities will no doubt depend entirely on the extent of its use.

The Values of an Adequate Civil Service System

By John B. Probst

IF THE title assigned for this paper had not contained the word "adequate," it would have been a far more difficult subject to discuss. An "adequate" civil service means to me a merit system in the true sense of the word, i.e., merit as reflected in the employee's all-around performance on the job,—his efficiency, his character, his conduct, and his seniority. There are very few real merit systems in public personnel administration. Most of them are merely "civil service" systems.

You do not have an "adequate" civil service: (1) if you are compelled to give preference in appointment to a war veteran, irrespective of his relative ability or standing on the eligible list; (2) if you must work under an inflexible seniority system as the sole determining factor for various administrative actions; (3) if you must fill the higher jobs with men who are deficient in the requisite qualities of leadership and executive ability; or (4) if the law deprives you of reasonable discretion in maintaining discipline or in effecting separations of employees whose services are distinctly below average.

The operating head must retain sufficient power to manage his department with the same authority as any competent and capable private executive, free from pressure, influence, discrimination, nepotism, or personal likes or dislikes. Such an ideal executive may be hard to find, but there are real executives who welcome reasonable restrictions on their own discretionary powers in order to save them from themselves. For such an executive, a merit system has much to offer, in that he can have: (1) freedom from political influence and pressure in dealing with his employees; (2) more time for constructive work in better administration, rather than dissipating his energies in dispensing political jobs; and (3) a better opportunity to maintain

A paper presented on June 25, 1941, at the Toronto Convention by John B. Probst, Chief Examiner, Civil Service Bureau, Saint Paul, Minn.

continuity of good personnel policies and practices and consequent better service to the public through higher employee morale.

Problems of Personnel Administration

I suspect that some of you are saying to yourselves: "Why, a good manager of a water department can and will do all these things himself without the help of civil service." Yes, but can he—or will he—or does he now do it?

Are the employees in your own water departments today being recruited through competitive tests to determine all-around fitness for the job? When you hire a ditch digger do you know whether he has heart disease, high blood pressure, hernia? Do you know whether he is a man of sound character and temperate and industrious habits—whether he has a police record? If you hire an accountant, how do you find out if he is in fact an accountant? His past experience with other firms is not a reliable index of his ability. Tests have proved this.

How do you know you are not employing a malingerer? Suppose one of your employees has an accident while at work and then puts in a claim for permanent partial disability of vision, have you adequate records to prove that the employee possessed only partial vision when he entered your service?

In just such a case, that occurred some time ago in St. Paul, the department saved itself $1,500. In another case an applicant was rejected for common labor employment because of a hernia. He was hired the next day in private employment. He collapsed on the job, was rushed to a hospital, and died of a strangulated hernia. The city saved $7,500 in that instance.

It is easy to answer that you can provide for medical examinations just as well as a civil service department. That may be true, but do you have them now? If so, are they standardized and under satisfactory control?

There is also that troublesome administrative problem of setting salary and wage rates and differentials, and of meeting the inevitable demands for changes in the rates after they are once established. How do you do that? Are your rates fair to all your employees? You answer: "Yes." How do you know? Why is it that practically every time a salary survey is made by an impartial outside agency, so many inequalities are brought to light in governmental departments, including water departments?

One of the fundamental principles of civil service is to solve this vexing problem of salary and wage administration. Proper pay standards must be predicated on a sound job classification, which in turn must be based on adequate job specifications and job descriptions. Without this prerequisite, the fixing of pay schedules will usually be influenced by causes other than the true worth of the job.

Another important personnel function is the filling of higher positions by promotion. Do you promote the best qualified man when there is a vacancy of higher rank? How do you determine that he is the best qualified? Is your individual judgment a safe guide? Might there not be a better qualified employee in your department whose name or work does not ordinarily come to your attention? If the better man is overlooked or passed over, what effect does that have on the organization? Do you still cling to the notion that production records alone are a safe guide? Do you have as good an inventory of your man power as you do of your pumping machinery, your filtration plant, or your other equipment? As a matter of fact, do you have any satisfactory method of appraising the all-around value of your employees? If you do not, then of course you do not have an inventory of your man power; and without such an inventory, how can you make promotions to higher jobs and be fair to all your employees?

For the sake of discussion, let us assume that there is in fact a water department administered at present by a board and a superintendent who believe in and practice the true principles of a merit system. Let us assume that their treatment of the employees is eminently fair and that the morale in the department is high. What assurance have you that the same personnel policies will be continued by the next or future water boards and superintendents? With a civil service merit system, such desirable policies would be retained and would provide "going-concern" value regardless of changes in management.

Admittedly it is possible, although unlikely, to build an efficient organization under even a spoils system, but experience proves that it will be an organization built on shifting sands. It is well for an executive to say that he is an exception to all this—that he has the necessary strength of character to ward off any pressure—but influence has a sinister way of gaining its point. It has ways of its own in molding executive discretion to its own views. Most public officials of long experience can testify to this.

Advantages of Civil Service

Under civil service, appointments must be made from eligibility lists. This alone takes away the incentive and the opportunity for an official to appoint his friends or relatives or political followers, or to appoint hundreds of unnecessary persons by creating many unnecessary jobs and titles.

Adequate civil service will provide for equitable salaries and fair working conditions through the adoption of common-sense, workable rules. These are matters that do not generally exist when there is no adequate personnel agency, and such practically never exists under a spoils system.

All this means economy. It means better qualified personnel. Persons appointed from civil service lists know that they are expected to put in a fair day's work and are not hired for the purpose of playing politics; and the department head can demand decent services from these employees, without fear of displeasing some local political boss.

I can agree with you that it may be hard here and there to discharge an employee under certain civil service systems, but is it more difficult than getting rid of an employee appointed by order of the local political boss? Indeed, is it possible to remove an unsatisfactory employee at all if the political boss says "No"?

It is sometimes pointed out that one of the weaknesses of civil service is that the higher administrative and executive positions are not always filled by men of real leadership. The contention is that some persons acquire a "knack" of passing examinations, and, then, through certain preferential rights, must be promoted to positions for which, in the judgment of the appointing officers, they are not properly qualified.

There may be occasions when this criticism is justified, but even here let me, in defense of civil service, point out that no other method of recruiting or promotion has demonstrated a better record of success in filling top positions. Every appointment or promotion under civil service is for an initial probationary period—usually for six months—and a good civil service law will require that the appointing officer file a written affirmative statement at the end of the probationary period, certifying that the probationer's services were satisfactory in every respect and that he is recommended for permanent appointment. With this as a safeguard there should be no serious hindrances in filling top positions as satisfactorily as in other classes

of employment, especially since the department head usually establishes the minimum entrance requirements for his own department.

I believe that it is the experience of civil service administrators, generally, that the responsibility for retaining in service any unsatisfactory appointee rests with the heads of departments. Some of these apparently assume that civil service is instituted to relieve them of all responsibility in connection with their personnel. That is wrong. Civil service was never intended to supply a spineless executive with backbone.

We realize that it is not easy to sell a civil service merit system to a thoroughly successful executive. Civil service laws and rules irk him tremendously. He is accustomed to give orders and to have those orders carried out and obeyed implicitly. He may rule with a strong hand, but does he know whether he has a smooth-working, loyal, and faithful organization? And can this same executive go on month after month in his management of personnel without allowing subtle influence, favoritism, friendship and specious reasoning to brush aside considerations of real merit? The old practice of bringing an apple to the teacher is still operating, but it is much more skillfully done in adult life.

Present-day civil service may not be the final answer for the most successful public personnel administration, but until a better plan emerges, your best bet is an *adequate* civil service merit system.

The Limitations of Civil Service

By H. A. Van Norman

A TREATMENT of the subject "The Limitations of Civil Service" should not convey the impression that a civil service jurisdiction is devoid of merit. As is common in many branches of governmental agencies, there is no perfect method of handling the many functions incumbent with serving the public. Civil service is no exception. It is certainly recognized that there are outstanding advantages to the merit system when conscientiously and properly managed and applied.

The topic to be discussed herein has been limited to facts which demonstrate that the present day civil service provisions, under governmental ownership, do have definite limitations which tend to impose hardships on operating functions of a municipal government. Comments will be aimed primarily at the effect of such limitations on an operating utility which serves water to a city of 1,500,000 population. No doubt many of the points presented herein will be common to most of the larger municipal jurisdictions in our country, as it is apparent that the charter provisions, creating civil service departments in so many American cities, have been made after the same pattern.

Ordinarily, institutions such as water supply utilities have two principal objectives, i.e., the construction of works and the operation and maintenance of works. The subject will be treated with these two phases of the industry in mind, taken up in the order stated, followed by a summary of the limitations which affect a jurisdiction generally showing the effect of administration of civil service by political regimes imbued with the spirit of the spoils system.

A paper presented on June 25, 1941, at the Toronto Convention by H. A. Van Norman, Chief Engineer and General Manager, Bureau of Water Works and Supply, Los Angeles.

Civil Service in Temporary Construction Projects

To impose a civil service jurisdiction on a temporary construction project of any magnitude is considered to be a "misplaced merit system." The employment of personnel under civil service rules for such in undertaking creates a hidden cost which is not susceptible of estimation but must be added to the cost of a construction project, and which amounts to considerable sums in actual money as well as in inefficiency. Situations enumerated herein are founded on actual experience during a large project recently completed by the Los Angeles Bureau of Water Works and Supply, which included the construction of two earth-fill dams, a concrete-lined tunnel over eleven miles in length, under the Mono Craters, and the construction of approximately eleven miles of conduit with appurtenant intake and spillway structures, which projects extended over a period of five years.

Mono Basin is 350 miles north of Los Angeles in a mountainous territory lying at elevations between 6,500 and 7,000 feet above sea-level. Extremely cold winters are experienced in the area, at times making it inaccessible to other parts of the state. Numerous camps were established at the various points from which operations were carried on and the latest type housing facilities were installed for the employees. Free transportation from Los Angeles was offered to all those employed to work on the project.

Jurisdiction of the regularly established Civil Service Department of Los Angeles was imposed on this project and governed the employment of personnel throughout the period of construction. At the inception of the project, such eligibility lists as were active and being administered by civil service were in rather poor condition, due to a period of lack of funds and a greatly reduced staff. This fact alone presented a serious limitation of the civil service system from the standpoint of serving a fast-moving organization period to initiate a large construction job. Almost immediately, it was apparent that it would be necessary to make temporary appointments in the numerous classifications in which personnel was needed. In some instances, where lists existed, they were inadequate due to their age.

The personnel of the civil service bureau, due to its reduced appropriations, had formed the habit of extending the period of eligibility of those on lists, and, in numerous instances, the lists were so old

that addresses were incorrect. Often, those on the lists had found other employment or had left the community, creating an almost impossible method of obtaining employees quickly. It was not uncommon to take 45 days to certify from a list containing 50 names and then to obtain only one or two workers from the list.

It was soon discovered that the construction project entailed phases of work and operations which had not been performed to such magnitude in any branch of the city government for several years. Large tunneling activities had been uncommon since construction of the original Los Angeles Aqueduct, during the period 1908 to 1913. It was, therefore, not logical to expect to find men experienced in hard rock tunnel methods on the existing eligibility lists which had been created by the civil service bureau at a time when such work was not even considered. As a consequence, it was found that the civil service classification scheme did not contain many of the classes required for employment of men on the various phases of the work.

Work however, had to go on while the civil service bureau was struggling to keep its bearings in the flood of requests for personnel, examinations, new classifications, and temporary appointments. The result was that the project got under way with personnel appointed only temporarily, subject to taking civil service examinations. Naturally, the personnel organization of the water department selected the best men available for the classes of work to be performed. Several months elapsed then, and during that time the temporarily appointed employees were being trained for the work involved.

During this time the civil service bureau was performing the research work necessary to frame examinations for the various classes being used on the project. Much time was consumed in conference with civil service representatives, examiners, and research employees, deciding what such examinations should consist of and what type of examination—written, practical, or oral—should be held. Eventually, examinations were started, keeping the employees away from the project for considerable lengths of time.

At the request of the water department the civil service bureau acceded to a plan whereby examiners were sent to the project to conduct the tests rather than requiring the workers to make the 350-mile trip to Los Angeles. All examinations to create eligibility lists for the project were open-competitive and, in numerous instances, the residence rule was waived in order to draw men from the fields in which they were occupied.

In due time eligibility lists were created and the project authorities were instructed to certify men from the lists in the order of their standings. The results immediately began to show. Almost complete turnover in personnel resulted. In many instances, the men who had been appointed temporarily did not show up on the eligibility lists and could not be retained on the project. It was necessary to institute a new training program and the work was carried on with inexperienced men until they had gained sufficient training to be proficient on their jobs.

Altogether, from 65 to 70 classes of employment were engaged on the project. Multiply the above situation by 65 or 70 and it will convey some idea of the turmoil, inefficiency, and headaches that resulted due to civil service jurisdiction. There were occasions, too, where the civil service bureau felt that existing eligibility lists contained men possessing the qualifications and abilities required on certain phases of the work. The argument that it was illogical to jeopardize an individual's status on an eligibility list by subjecting him to an occupation outside his previous experience proved useless, so such plans were carried through.

Misapplication of Eligibility Lists

Civil service eligibility lists are available for use by any branch of the city government, covering employees in all the numerous departments. Fate has considerable influence on the future of an individual on such a list for a certain occupation. Should he be exposed to a position which is not within the realm of the qualifications and abilities for which he was examined, he would undoubtedly be discharged during the probationary period and his name removed from the list. An injustice would be done to the individual as he might be an excellent employee in some other department where the work was in line with his experience. In spite of this reasoning it was occasionally necessary to undertake the arduous method of attempting to find sorely needed men for a particular phase of the tunneling operation from unsuitable eligibility lists.

An outstanding example is the case of a steel sharpener. The classification of "blacksmith" had existed in the civil service records for many years. Due to the demands of the city government, men on that list had been essentially forge men, and examinations for many years had been framed so as to attract good blacksmiths working at the forge. It should not be necessary to go into detail on the

duties of a drill steel sharpener in this day and age of automatic machines, high-speed work and modern high-carbon steel, furnaces, etc. A fairly new eligibility list for blacksmiths, containing approximately 50 names, however, was available and the civil service bureau decided that there could be found among that group of men, somewhere on the eligibility list, a qualified steel sharpener.

In the meantime harder rock had been encountered in the tunnel and the amount of steel used per round had almost doubled, necessitating an additional shift on the steel sharpening function. After approximately three weeks all the eligibles that were willing to risk their position on the list by attempting a job in which they were not highly specialized had been interviewed. Of the 24 men reporting, five were sent to the project. Four were discharged after one or two days' trial and one finally succeeded in learning the tricks of the position, and remained on the job as a steel sharpener until another man under temporary appointment had been sent to relieve him.

During the period of acquisition of a steel sharpener, other headings on the tunnel had turned hard and more steel sharpeners were needed. In desperation steel sharpening specialists were sought through every conceivable channel in the community and eventually several men were acquired and employed on a temporary basis; but not until one month of inefficiency and turmoil had elapsed was it possible to convince the civil service bureau that steel sharpeners and not blacksmiths were needed. Even then the problem was not completely solved because the bureau felt that it should call an examination in order to qualify the men selected temporarily and to induct them into the classified service. Therefore, the project again had the inescapable endless chain of events, when the examination had been held and the eligibility list submitted, and the men selected were not in a position to be certified.

The difficulties enumerated with respect to these positions apply to many others, such as: a "mill man," required to frame large timber sets used to support a construction shaft and in heavy tunnel work, and for which employment the civil service bureau had only an eligibility list for carpenters; "drill doctors," where an eligibility list of machinists was used in an effort, barely possible, to find a man. In these and many similar cases it was again necessary to go through the procedure of making temporary appointments and then to reorganize at the time eligibility lists were published.

Difficulties With Job Classification

Another phase incumbent with civil service jurisdiction, which does not work to the advantage of a construction project, is the classification system. A construction project is not similar to an assembly line where the work moves past the workman and each has his own operation to perform as the work moves by, but is more of a "high-ball," rapidly changing situation. Numerous conditions operate to change the method of attack, type of equipment, and personnel. It is absolutely essential that men, who are often referred to as "jacks-of-all-trades," and many of them, be available on such work. Civil service in Los Angeles is bound by the charter to establish classes for all offices and places of employment included in the conduct of the city's business. Each class must, therefore, include all positions sufficiently similar in respect to duties and responsibilities, in which: (1) the same requirements as to education, experience, knowledge, and ability are demanded of incumbent; (2) the same tests of fitness may be used in choosing qualified appointees; and (3) the same schedule of compensation may be made to apply with equity. Being under civil service jurisdiction, all positions on the project were consequently classified in accordance with the above statute provisions. It would require many pages to illustrate all the difficulties encountered due to the numerous narrow classes thrust upon the authorities in charge of this work.

Civil Service in Normal Operating Functions

Civil service proponents would probably say after hearing of such an experience that construction projects do present somewhat of a problem, but that these limitations should be practically nil in the normal operating functions of a city government. It is true that the disadvantages are greatly reduced on functions where there is practically no personnel turnover and where the work flows in well defined channels continuing at a uniform rate year after year. Nevertheless, limitations under civil service jurisdiction do exist in the operating functions of a public utility, as will be shown.

So often has been heard: "If only the charter could be adjusted to take care of the troublesome situation." As civil service jurisdiction must originate through charter provisions of a city, or appropriate statutes in other governmental agencies, it is the first point where

limitations might be evident. Public opinion, standards of living, business methods and fashions change materially with time, and employment and personnel relations are bound to follow the same cycle. Statutes governing a civil service jurisdiction cannot be expected to meet the needs for long periods of time without modification. Consequently, it is a mistake to draft the civil service laws in such a manner that a vote of the people must be relied upon to keep in step with changing conditions.

One of the greatest faults of a city charter and other statutes is that their civil service provisions are so finely drawn in great detail that a frozen condition is created. This situation is unhealthy to a city administration when it keeps the civil service bureau from keeping in step with modern trends. Civil service laws would be much better if they were worked up in the light of an enabling act. Give the bureau a base line from which to extend its jurisdiction, so that by simple modification of its rules and regulations it can readily meet the demands of time.

Some might say that such an enabling act would give the politicians the free hand which they so greatly desire. It is submitted that a political administration with a desire to tear down the merit system will do so in spite of statutes governing their jurisdiction. The people have recourse in the event of such political maneuvering by removing those undesirables from public office through the process of referendum.

Fluctuations in Supply and Demand of Labor

The law of supply and demand is well known to all those engaged in business. Of recent years the supply and demand in our country has been seen to fluctuate materially due to changing economic conditions, not only of this country but of the world. Civil service must be classed in the category of a supply agency which serves governmental agencies of all sorts. Consequently, it necessitates fluctuations in civil service administration to compensate for the variations in demand. One of the most common limitations of civil service is the inability to change its system to meet the frequent fluctuations in supply and demand.

Speaking of labor, there are times when the supply is plentiful and other times when it is low. During periods of plentiful labor, personal requirements for employment increase and wages decrease, while during periods of low supply of labor personal requirements

for labor decrease and wages increase. Unless civil service is allowed by its law to change its methods and standards rather suddenly there is a definite lag created which works greatly to the disadvantage of city government.

During the recent depression, when labor was plentiful, civil service was obliged to raise the requirements for competition through examinations for employment in the city government. This was necessary in order to obtain the best persons available for certain types of work. Had the requirements been low with large numbers of candidates available, undesirable results would have ensued. Now, rather suddenly, it is discovered that due to the extensive defense program and international relations generally the picture has changed. Labor demands a premium. The best qualified persons in various lines of work have found employment. Conscription is taking from the city government the younger men who have recently entered the public service. A demand is thereby created. Civil service eligibility lists become rather active in order to fill the vacancies occurring, and there is manifested a serious weakness in the system.

The eligibility lists available are the result of examinations given as long as two years ago, at a time when labor was plentiful. The best qualified persons on these lists have found employment in the rapidly increasing program and it is impossible to obtain employees as needed. Civil service must, then, go into action to examine new candidates to create a new eligibility list, but unless there is an awareness of the situation, the qualifications imposed will be the same as those used in the previous examinations, and the resulting eligibility list, if any, will be small. Thus, it is discovered that requirements are too high for the supply at hand and that another and easier examination must be held.

In the meantime those who might have been attracted to public service have found places in private or federal employment and the best of the supply has gone beyond the reach of public service. A good example is the examination held for Junior Clerks in 1935. The supply of high school graduates who are usually sought as Junior Clerks was then plentiful. The civil service bureau, however, established qualifications which required practical experience, and the eligibility list which resulted contained the names of individuals whose ages averaged over forty years. The desired young talent was lost through the short-sightedness of the civil service bureau.

Need for Flexibility in Enabling Legislation

It is practically impossible for any civil service bureau to meet such conditions as they arise if it is bound by faulty charter provisions or statutes which will not permit a change of course. Reference is made to the difference in needs of the various branches of a city government with respect to civil service jurisdiction. A water supply utility, or a power supply utility, is quite different from the common run of municipal departments such as fire, policy, and of several others. In the fire and police departments a nominal number of classifications exists, and their activity is more or less limited in scope as they perform only one main function. Compare such departments with a water department which must have almost every conceivable type of workman in order to maintain an operating organization. Civil service, however, attempts to classify employees somewhat common to each department under one class.

Engineers, for example, are fairly common to any branch of city government. In most large cities there is a street department, a sewer department, a storm drain department, and several others in the engineering field, in addition to water supply. The city engineering department is a tax-consuming function and is subject to fluctuations due to economic changes, whereas the water utility is a more stable organization. Engineers in the various departments hold the same classifications under civil service. During depressions it is necessary for the city engineering departments to reduce their forces by laying off men experienced in design of streets. These persons are returned to preferred eligible lists where they remain for a period of five years. Vacancies occurring in the water department must then be filled from such preferred lists, and it is necessary to employ street designers to work on hydraulic structures. Such a condition is not conducive to efficiency in a public utility, for engineers in the water department must of necessity be more or less specialized in hydraulic engineering, yet when the need is acute it is difficult to obtain men with those qualifications.

Civil service has a tendency, due, as stated previously, to the statutes under which it operates, to impose many more classes in city employment than are necessary. In order to compensate for the changes in volume and scope of work it is frequently necessary to enlarge or change an employee's duties. If the classification system provides narrow grouping of activities there is no flexibility available

to adjust for changes in work. If too many classifications are established, eventually they will become overlapping and in some instances it will be difficult to distinguish between them. One group of clerical classifications will work satisfactorily in one city department but it does not hold that such will be the case in all other departments.

A weak classification plan will definitely limit the effectiveness of civil service jurisdiction. There is a tendency on the part of civil service boards to create an excessive number of classes; in part, this tendency is due to a political maneuvering where the plan is so unstable as to permit the abuse of the merit system. The possibilities under such conditions will be explored later. The expense of an examining division in a civil service department would most probably be in direct proportion to the number of classes being administered under the system. It would be in the interest of economy, therefore, to limit the number of classes under civil service.

There are direct disadvantages to the operating functions in controlling personnel under an excessive number of classes. In the water works industry, the engineering series of classes is most common, and if numerous steps are established in the promotional series, it becomes difficult to differentiate between the types of work performed by the engineering staff. In a large organization, especially those having retirement plans, the movement of personnel up the promotional ladder creates numerous changes annually. If the steps in a promotional series ladder are narrow, the changes will be increased and the number of examinations likewise increased. If the civil service output is geared to the rate of promotions, and tax funds are available to continue the necessary pace, the ill effect of too many classes is somewhat minimized.

Problems of Promotions and Salary Increases

It is found by experience that fluctuating allotments for tax-consuming departments prohibit the maintenance of such an examining program as would be necessary with too great a number of classes. During periods when tax allocations are greatly reduced, the revenue-producing water utility does not ordinarily slow down proportionately. Its needs continue at almost the normal rate, yet civil service is totally unable to compete with the demand created by movement in the promotional system. The water utility is forced to make the necessary promotions physically without being able properly to classify those earning the promotion. In many instances

the appropriate salary cannot be given at the time a promotion is granted due to this inability to make proper classification.

There have been cases in point where an examination for Junior Engineer has not been held for eleven years, yet numerous promotions were necessary due to growth of the utility and to retirements in the higher brackets. These employees would have been severely penalized due to the limitations of civil service had the governing board been unwilling to distort the pay scale provided for the lower classes. It was only through this means that it was possible to maintain the desired morale of the employees when it was necessary to require higher duties and responsibilities of them without being able to adjust their classification appropriately.

Incidentally, the matter became so extenuating that some of these employees, during the eleven-year period, had been promoted twice before an examination could be given. Pay scales were so badly distorted that the classification in question provided for a higher maximum salary than the one immediately higher in the series. Too many classes subdivide the work to such an extent that it is difficult to detect any appreciable difference in the duties and responsibilities of each. Under such conditions it would be extremely difficult to examine for the various classes. The differentiation between knowledges, abilities, and duties would be so small that examinations would of necessity overlap. This would, of course, greatly minimize the value of the examination method.

Need for Flexibility in Job Classification

Evasion of civil service rules by making employees work out of their proper class is an often heard claim. Civil service must maintain nominal policing organizations to carry out the terms of the statutes under which they operate, but their classification scheme should be such that it will not force evasions of their rules. In this connection, too, numerous narrow classes are at fault.

Work functions will invariably fluctuate, particularly in a public utility. To use an engineering personnel most effectively, for instance, it has been found convenient to employ field men in the office during the winter months and in the field during the summer months. Utilities must contend with these seasonal fluctuations, as the elements cannot be changed, yet strict adherence to the duties prescribed by the employee's class would make it impossible to adapt the employee's work to such conditions.

Some deviations must be made from the narrow classification system due to periods of construction when several projects are in progress, as compared to periods when the utility is on a purely operating basis. Flexibility is demanded under such conditions. An aggressive utility will find it necessary periodically to overhaul the various functions of its organization. Efficiency studies may show that the consolidation of two or more divisions will effect economies and eliminate duplication of effort. When it appears that such consolidation is to the benefit of the public it would not be logical to wait for civil service to amend its system in advance of such consolidation.

A rather major change in organization would naturally make numerous re-allocations of duties among the employees. Service ratings show that employees will fit into certain positions in the organization, and in the interest of economy, in re-allocations of work these ratings must be considered. The amount of work necessary on the part of civil service bureaus following such a move depends entirely on the number of classes imposed by them. A classification system which would permit a major re-allocation with very little adjustment can be visualized, though, of course, there is a limit to the broadness of civil service classes.

Problems of Specialization and Superannuation

The need for specialization in practically all professions and lines of endeavor must not be overlooked. There will undoubtedly be numerous positions in all organizations which require men that are specialized in a fairly narrow field. It is logical to assume that separate classes will be necessary to fill such positions, in order that specialists may be obtained when needed. There is also a great need, however, for a median between flexibility and specialization in order to serve the public utility under civil service jurisdiction more effectively.

Superannuated employees often present a problem due to the limitations of civil service statutes. At times, employees, long in public service, because of old age, become unable to continue on the work for which they are classed. Linemen present a good example of this point, as pole climbing is an arduous task. It is not uncommon for such employees to become unable to climb poles without excessive hazard to themselves. It is felt that public opinion would not condone the dismissal of these employees who have served well in their

positions. These men should be allowed to pursue an occupation as long as they can do so gainfully. A civil service bureau should be able under its laws to re-allocate such employees' duties to work on which they could earn their pay. In drawing up future civil service statutes this point should be given serious consideration. The effect on public opinion of being able to adjust the organization to permit utilization of its help in the most efficient manner is an important factor.

Public service, which is not a career service protected by the promotional system of examinations, will not attract the best qualified persons to serve the public. Political régimes favoring the spoils system usually attempt to destroy the promotion feature of civil service. In order to place political favorites in the desirable positions, examinations must be held open-competitive so that those to be provided for may compete. Promotional examinations would exclude them so that the only opportunities afforded would be in the entrance positions. Pay-off with entrance positions in public service will not buy many votes. The promotional features of a career service should be adequately safeguarded in the civil service statutes.

These comments have been offered from the standpoint of an engineer charged with the responsibility of providing and safeguarding a large city's water supply, rather than that of an authority on merit systems. They represent the observations of one who has for many years been on the receiving end of the results of good, bad, and indifferent civil service administrations. No attempt has been made to exhaust the subject. Rather the author has tried to cover the salient points which might be considered in improving the merit system.

Discussion on Civil Service

By E. V. Buchanan

IT IS not possible for me to do more than express a few opinions in discussing the papers by Messrs. Probst and Van Norman. Although I have spent all my life in municipal service, I have no experience with the so-called merit or civil service system.

As far as I am aware, no Canadian city has any civil service system comparable to those in force in a number of the larger cities in the United States. The only extensive civil service in Canada is that of the federal government which appears to function well. It is readily admitted that employees of the federal government of a vast territory such as Canada must necessarily be controlled by some form of civil service, but the necessity for such control is not so apparent as it pertains to employees of a city and especially to small or medium size cities.

Both papers repeatedly stress the dangers of political interference and this leads me to the conclusion that conditions in this respect must be widely different between the United States and Canada. In my own experience of 27 years as a utilities manager I can say positively that there has been no political influence used in obtaining jobs.

It should also be pointed out that there has been a growing movement in Ontario toward the management of utilities by an elected or appointed commission composed of three to five members holding office for more than one year. The majority of municipal utilities are now governed in this manner. These commissions function through a manager and thus tend to operate more like private business corporations than do city councils. Thus, "political regimes imbued with the spirit of the spoils system," as Mr. Van Norman puts it, are not a factor affecting municipal civil service in Canada.

A discussion presented on June 25, 1941, at the Toronto Convention by E. V. Buchanan, General Manager, Public Utilities Commission, London, Ont.

Both authors have urged broad and flexible civil service statutes and regulations; but if the regulations are broad enough and flexible enough to overcome the limitations indicated, are they not also flexible enough to permit the feared politican to gain his purpose?

In Canadian municipal utilities many of the advantages of civil service are obtained by other modern devices. The pay scales are controlled to a great extent, except for the engineers and executives, by the labor unions, and surely the grading and promoting of engineers and executives can be accomplished much more fairly by a commission and manager than by a set of rules based on classes and seniority. It is much easier to classify jobs by regulations than to classify human beings. Lord Kelvin once said that no field of research became a science until it could be measured. As yet there has been no yard-stick discovered to measure human aptitudes and characteristics.

Again, the adoption of insurance and pension schemes, with medical examination and sickness benefits, which are becoming more and more common, gives all the continuity of good personnel policies and protection for the employees which are to be obtained by a civil service system.

Salary Limitations in Civil Service

Civil service schedules tend to limit the salaries of higher officials to amounts lower than those for similar positions not so governed. For instance, in Canada, the salaries of technical and professional men under civil service in the federal government are definitely lower than those of similar employees of the Ontario Hydro-Electric Power Commission, and the salaries of municipal utilities executives and engineers are also higher than those for more or less similar positions held under city councils. It should be admitted, of course, that the fact that utilities expenses are covered by direct revenue, rather than from taxes, may have some bearing on this situation, but it is suggested that civil service commissions, which after all are politically created, have not the courage to establish adequate salaries in the higher range of the scale.

In 1930, in a report of a Royal Commission to the Canadian Government, on salaries of technical and professional officials of the Civil Service of Canada, the following statement was made:

"It seems almost superfluous to observe that positions involving public responsibility of a high order can only be satisfactorily filled

by men of sufficient financial independence to enable them to perform their important duties free from the worries and distractions which inevitably follow financial embarrassments, even of a minor nature. Any other situation would inevitably mean that such appointments could only be accepted by men of ample private means, thus limiting to an embarrassing extent the number available for such positions. Obviously, the annual compensation which should be paid to the incumbents of these offices should be adequate and even generous, if the services of men of high calibre and the requisite ability are to be obtained."

I do not believe that the Commission's report did much to correct this situation.

The conception of efficient democracy today presupposes an efficient corps of civil servants. It is based upon the assumption that the public as a whole is entitled to service, and that the administration should aim to secure service no less devoted and able than that which is at the command of private enterprise. Private enterprise has not attained its successful results by rules, regulations and schedules, but rather by entire freedom of action.

Too many rules and regulations, too much regimentation is not democracy. As I said at the beginning, I am not afraid of the politicians. They are not always wrong and cannot be wrong for long and get away with it. I have great faith in the will of a free people to run their affairs. Inefficient, incompetent, and dishonest civic employees are more likely to remain in service longer under a civil service system than otherwise. Where there are no hampering statutes efficient and competent employees will more quickly obtain their reward. The knowledge that such is the case will develop initiative and loyalty among the employees in a way similar to that in which they exist in private enterprise.

ABSTRACTS OF WATER WORKS LITERATURE

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DEFENSE

Journey to England, 1941. ELMER DAVIS. Harpers. **183:** 223 ('41). *Excerpts.*

[In answer to the question: "Does it look as bad as you expected?"] "No—not at first sight, anyway; looking a second time, more closely, you perceive that a good many front walls have nothing behind them. But still it isn't as bad as you expected, though it may perhaps be worse by the time you read this. London has suffered terrific damage, but it is a big place and by far the greatest part of it is still there. In many parts of London most of the windows have gone, broken by concussion; and it makes little sense to replace them when they might be broken again in the next blitz.

"There are spots in London, as there are spots in other cities, where whole blocks are in ruins; there are rows of great houses of which almost every one is a blackened shell; and you can still travel for miles in areas utterly untouched. But the commonest sight is a street in which only one or two houses have been wrecked. Sometimes a single high explosive; more often the work of fire bombs falling on the roof of an empty house, whose fire watchers, if any, had gone to the country for the week-end.

"It is literally true that many Englishmen, who would willingly lay down their lives for their country, have refused, so far, to lay down their week-ends; and at this writing it is precisely these fires in empty and unwatched buildings that are the most serious problem of the air raids. They have been the most serious problem ever since the great fire in the City of London on December 29th, but nobody has taken drastic action yet.

English Ports

"I saw five seaports—Southampton, Plymouth, Bristol, Liverpool, and London—which had been repeatedly blitzed, and so far as any damage done by the Luftwaffe was concerned, they were all still functioning. They all had been hit and hit hard, but none of them had been anywhere near put out of action.

"It violates no secret to say that in each of these towns the principal damage was done in the business district—except perhaps at Plymouth, where business and residence districts were battered with an equal ferocity.

"You can do a great deal of damage to an organized community by wrecking most of its business district; you can put people to the trouble and inconvenience of finding new places to buy things—places much farther away, perhaps even in the next town; you can discommode everybody, slow them up, reduce their individual and collective efficiency. Make almost half their homes uninhabitable, as was done at Plymouth, and you hamper them still farther.

"Plymouth is a testimonial to how much people can take and still keep on

working: yes, but it also suggests that there is a breaking point somewhere—not yet reached—beyond which they cannot take it no matter how firm their resolution. There is some sense in the Germans' insistence that they hit nothing but military objectives: for when you are making war against a whole nation and its will to victory everything is a military objective—stores and homes and hospitals as well as docks and railroads and power stations."

Civil Engineers and the War. A. G. BEAUMONT. (*Abstract of Chairman's Address to the Yorkshire Assn. of the Inst. of Civ. Engrs.*) Wtr. & Wtr. Eng. (Br.) **43:** 123 (Apr. '41). No guarantee that after present war world will be free from air attack. Concentration of works and massing of pop. seen to have grave disadvantages. Water works stores may be taken as simple illustration. Necessary to have branch depots for materials, tools and equipment. Pumping stations must be designed to avoid complete interruption of their services. Bldgs. where beams supported on brick or stone walls readily collapse. Organizations representing water works interests must exercise vigilance to see that interests of public not prejudiced through acts, orders, or instructions traced to some unusual happening, such as drought, outbreak of disease, or major accident. Reservoirs Act of '30 followed failure of Dolgarroch dam. Provides that large reservoir can be constructed only under supervision of qualified engr. Water Undertakings Bill ('39) pressed forward when water works authorities requested to concentrate attention on air raid precautions (A.R.P.). Found to include radical changes in principle, impossible burdens and restrictions; and much that was objectionable. Owing to war, bill was dropped. Croydon epidemic of typhoid fever led to issue by the Ministry of Health of two carefully compiled circulars: to the supervision of sources of supply and the medical examination of workmen; and to the use of sterilization by chlorine or similar means as a final line of defense. Civil defense now includes what was formerly known as A.R.P. Before outbreak of war, Govt. placed water works in same category as industrial firms. Water undertakers responsible for complying with "good employers" code, including such matters as special training of men, clothing and equipment, protection of works. Among measures for ensuring continuity of supply may be mentioned decentralization of stores, increasing stocks of tools, materials and appliances for 'first-aid' repairs. For works of this nature, grants (financial from Govt.) up to 50% made. Provision of tanks to be carried on lorries elementary but practical way of giving some kind of water supply to districts cut off. Damage to major works difficult to provide against. Seems unlikely that large dam could be seriously damaged by aerial bombardment, but there is risk of sabotage. Employees have been keen to join units of Home Guard and to assist in patrols. Water consumption increased in many large towns, owing to war industries. Abnormal weather experienced since war began also influenced water consumption and caused other difficulties. Frost caused large numbers of service pipes to freeze. Few small mains frozen. Hot dry weather led to increased consumption by trade and domestic users and probably by enthusiastic gardeners "digging for victory." Govt. dept. recommended householders to fill baths and buckets to have reserve of water for extinguishing fires. Obviously, when alert sounded, there would be such a heavy draw on mains as to reduce pressure for official fire brigade. Subsequently explained that used water should be kept. Diagram from principal Venturi meter threw some light on the habits of people during night alerts when no raids followed. Seen that very little water drawn at beginning or during period, but sharp rise when all-clear sounded, and people used water for tea and sanitary purposes before going back to bed. Two alerts in same night showed identical results. In reconstruction in wider aspect, engr. can play useful part.—*H. E. Babbitt.*

Water Supply Troops Organized. ANON. Eng. News-Rec. **127:** 170 (July 31, '41). New water supply battalion will be formed at Camp Livingston, La.,

as part of Third Army, with strength of 19 officers and 407 men. Will be equipped with 9 mobile purif. trucks and 90 tank trucks of 750-gal. capac. Medical personnel will conduct tests of quality. Responsibility for supply of potable water to troops in theater of operations rests with Corps of Engrs. Divisional engrs. responsible for supply of water within Division, corps engrs. within Corps and water supply battalion within Army and GHQ. In addition to equipment of water supply battalion, water supply equipment also carried by all combat engrs. and certain special engr. units. Consists of portable water purif. unit and two 3,000-gal. canvas storage tanks. Mobile unit carried by water supply battalions consists of gasoline-engine-driven centrifugal pump, dry chlorine feeder, alum and soda ash pots, 42″ pressure sand filter, piping, hose and lab. facilities. Unit, which is mounted on truck and weighs about 8 tons, can supply about 4,200 gal. per hr. Portable unit carried by combat engrs. consists of 17″ pressure sand filter, gasoline-engine-driven centrifugal pump, calcium-hypochlorite solution feeder, alum and soda ash pots and lab. facilities. Unit has gross wt. of about 750 lb., may be transported in any standard half-ton truck or trailer, and can supply about 600 gal. per hr.—*R. E. Thompson.*

The Utilities and the War. Herbert Corey. Pub. Util. Fort. **28:** 3 (July 3, '41). (First article of this series abstracted Jour. A.W.W.A. **33:** 797 ('41).) If new Army not more than 1,000,000 men, and emergency's limit 1 yr., utilities will not worry about man power. If Army expands to 4,000,000, then utilities and everyone else will be in "dreadful mess." Utilities need continuous trickle of new blood: engrs. now in stock sufficient, but steady line of supply essential. Now slowing down. Under Selective Service Act, at start, men taken in certain age brackets. Germany handled problem more intelligently. Engrs. put in "feldgrau" only if engrs. needed. Lessons all spread before us but we are just getting them now. Young engrs. give utilities fish eye if not assured of deferment and seek accordingly. More value as trained men than carrying rifles. Without engrs., no guns. If drafted man on the first rung of the ladder towards promotion, means man below will move up. Utilities working on modified civil service plan, seniority governing to large extent. Muscle men at foot of ladder, however, need not stay there if they have equipment with which to climb. Drafted man upon his return will find industry has progressed during absence. One of largest utilities has assured draftee his relation to pension plan will not be affected. This utility has no credit union, but does pay draftee's group insurance premium during his service. Writer has not been able to find any general who will off the record, say that he has least fear that this country will be involved. Fear that with Office of Civilian Defense under full steam, many earnest civilians will be in their Army hair at all times. Probably fear most of all helpful ladies—saying that helpful lady in full cry is one of nature's most awesome sights. Majority of large utilities have taken precautions to prevent cessation of service. Coal and equipment deliveries watched from source to delivery; construction work partitioned off from operating zones; manholes safeguarded; electric release devices fitted to doors and windows. None of these protective means of value if somewhere on company's register, name of wrong man to be found. —*Samuel A. Evans.*

Thinking Ahead of Disaster. James H. Collins. Pub. Util. Fort. **28:** 11 (July 3, '41). In '24, fire chief of Los Angeles started investigating available help to fight conflagrations. Citizens' Preparedness Com. formed to study disaster hazards; utilities and Chamber of Commerce interested. Major Disaster Emergency Council created by city ordinance, thus question of funds answered, tax money being available from city depts. in Council. 14 coms. charged with emergency activities; concentration points mapped out; each com. having perfected organization. City water dept. prepared 87 pp. printed report outlining duties of personnel, location of all equipment—size and other pertinent factors—location and amount of supplies

such as pipe and valves. War set every community to thinking what it would do if bombed, many plans being put forward with considerable confusion. Probably master plan will be evolved as sought by National Advisory Council on Home Defense. Such master plan will permit communities to adopt what has been found good in Los Angeles and Long Beach plans, without years of preliminary study.—*Samuel A. Evans.*

Emergency Water Supply. ANON. Civ. Eng. (Br.) **36:** 414 (Mar. '41). War, with its hazards, ever fruitful of new ideas. To meet extensive fires, well-known engr. drew up following scheme, object of which was: (1) to provide supply of water greater than present arrangements, for fire fighting; (2) to release for actual fire fighting many appliances now used to give improvised supply; (3) to make available supplies from any source; (4) to provide distr. facilities that are less vulnerable to damage and more efficient hydraulically than canvas hose; (5) to eliminate need for intermediate booster pumps; and (6) to eliminate bursting of hoses. Scheme consists of set of compact portable electric-driven pumps delivering into large bore steel pipes terminating at portable tanks or coupled to fire engines. Pump used—a marine salvage pump—has waterproof electric motor and may be dropped into a dock or river if water below suction level. Power for pumps, of which there would be 7 per unit, provided by alternator driven by aero engine of 650 h.p. at cruising power. Water from pumps delivered into 10″ bore steel piping with quick-acting couplings, giving some flexibility. At least 6,000′ of pipe would be provided with each unit. Pipe would be laid by 126 men divided into 6 gangs working simultaneously on 6 sections. Generator and engine would be mounted on 7-ton truck. Both generator truck and gasoline cars would be equipped with water spraying nozzles to keep them cool. 20 such units placed at stragetic points throughout country would enable 2 units to be concentrated at any point in from 1 to 2 hr. and up to 6 units in 6 hr., in main industrial areas. —*H. E. Babbitt.*

War and Water Service. NORMAN J. HOWARD. Eng. News-Rec. **126:** 955 (June 19, '41). Brief discussion of problems created by war. Consumption throughout country increased 3–12% and still rising. Engrs. returning from war zone do not consider chemical poisoning of water supplies real danger, but bacterial contamination, e.g., with dried typhoid cultures, possible. Continuous disinfection of all open distr. reservoirs therefore advisable. Some 110 military camps established in Canada and question of water supply difficult one. More consideration should be devoted to emergency measures, e.g., repair of broken mains, auxiliary supplies, portable disinfection equipment, etc., to be adopted in case war spreads to this continent. Such provisions should be made now while there is time.—*R. E. Thompson.*

Water Waste Prevention in War Time. T. ALLENDER CECIL. Surveyor. (Br.) **99:** 311 (May 9, '41). Necessity for investigations into water waste prevention may be divided into 2 broad headings: (1) increased consumption and (2) disorganization due to air-raid damage. Former may be due to transfer of civilian pop. to area, troop encampments or transfer, or development of war industries. Water waste prevention, or considered as additional storage scheme, can be of material assistance to all engrs. confronted with shortage of water. Disorganization of water supply system through air raid damage covers very wide field and may be roughly sub-divided as follows: (1) Damage to water works and trunk mains. (Cause of water wastage in works such as these would, most likely, be all too apparent.) (2) Damage to distribution mains, service pipes and house fittings. (This calls for same type of treatment as trunk mains but great deal more detail necessary.) Under second head record plans essential so that we may know size and position of main, sluice valves, etc. and also any peculiarities of fittings, outs, air valves, etc. Sound condition of various fittings natural part of record plans and conditions of water fittings inside house, matter for house to house inspection. Testing of

mains and fittings by water inspector, using stethoscope most common form of waste prevention but has its limitations. Method of using water waste meters well known. Combined use of stethoscope and electric leak locator should result in best results from each.—*H. E. Babbitt.*

Waterworks Practice in Italy, With Special Reference to the Bombing of the Tirso Dam. DELWYN G. DAVIES. Wtr. & Wtr. Eng. (Br.) **43:** 116 (Apr. '41). Since last war, Italy has not been slow in recognizing potential wealth which lay in powerful resources of high mountain valleys with their abundant watercourses. Development of these natural assets to supply electric power to industrial north would have enabled her to reduce one of her greatest expenses—importation of coal—to detriment of Britain. Italian engrs. can point with pride to large no. of reservoirs constructed during past 40 yr. Design of dams restricted by state regulations until '31, when greater liberty of action allowed to designer of smaller structures. Earth dams, other than those of small size, only employed when masonry types cannot be built with safety. Gravity dam design in conformity with trapezoidal rule of pressure distr. and no-tension in concrete. Largest dam, completed in '34, attains height of 246′, and belongs to arched-gravity type, being curved to radius of 650′. Recent bombing of Tirso dam in Sardinia new development in strategy of war of considerable interest to dam designers and water engrs. Highest multiple-arch dam in Europe. Type more vulnerable to air attack than conventional solid types. Until detailed reports become available, not unreasonable to speculate as to damage inflicted. That dam was hit has been officially admitted by Italian war communiqués. Possibility of overturning dam of this type can be dismissed. Principal weakness of all hollow dams generally that of sliding. Impact and explosive forces of torpedo likely to be expended in piercing slender arch barrels. Magnitude of subsequent flood depends on size of fracture and position relative to water level of reservoir. If attack proceeded from downstream side, visible target unusually large. Chances of direct hit on arch barrels increasingly remote with increasing inclination of trajectory. Hit to downstream side would cause serious damage to power installation. May be concluded that, although serious damage can be inflicted on multiple arch dam, achievement of total destruction from aerial sources may be precluded except under most favorable conditions. Danger from parachute troops infinitely more serious than that from planes. Obvious that water works particularly susceptible to this form of attack. In light of these different raids re-examination of both passive and active defense of water works deserves most immediate and thorough attention if danger to most vital of public services to be reduced to minimum.—*H. E. Babbitt.*

Bacterial Contamination Improbable as an Implement of War. CARLO G. FLEBUS. Civ. Eng. **11:** 147 (Mar. '41). (See Jour. A.W.W.A. **33:** 795 ('41).) *Discussion. Ibid.* **11:** 361 (June '41). CHARLES T. CARNAHAN: Do not agree with Flebus' conclusions in view of weight of evidence to contrary. Epidemics of water-borne diseases have been reported traced to accidental contamination of water supplies by organisms from active case from carrier. Plenty of evidence to show transmission of infectious diseases from one continent to another with, if anything, increased virulence due to lack of native immunization against particular strain introduced. During past few years biologists have given attention to use of certain plankton forms as indicators of pollution. In any polluted body of water, zones of pollution tend to overlap. In addition to sabotage of water supplies by bacterial contamination, possible use of milk and other foods as means of spreading bacterial infections should not be overlooked.—*H. E. Babbitt.*

Radial Wells for Powder Plant Water Supply. ANON. Eng. News-Rec. **127:** 155 (July 31, '41). Recent installation, perhaps largest single ground water project in world, provides max. capac. of 49,000 g.p.m. for War Dept.'s Charleston, Ind., smokeless powder plant. Seven,

13′ inside diam., collectors spaced along Ohio R. about 1,800′ apart and approx. 100′ inland now in operation. Collectors vary in depth from 80 to 110′ and bottoms closed with concrete plugs. Just above plug, at elev. of 50′ below mean water level in river, 10–14 slotted screen pipes, 8″ in diam., extend horizontally up to 257′ into water-bearing strata consisting of sand and gravel. Temp. of water obtained almost uniform at 60°F. and iron content less than 0.01 p.p.m. Collector shafts built up to 46′ above normal river stage, 1′ above '37 flood level, and each surmounted by machinery house containing electric-driven centrifugal pumps. Method of construction described. Withdrawal of fine material during construction creates gravel pack 3–6′ in diam. around each slotted pipe.—*R. E. Thompson.*

Heavy Equipment Beats Army Camp Mud. ANON. Eng. News-Rec. **127:** 12 (July 3, '41). Chorro Creek Valley, Calif., used for some years for summer encampment of National Guard, selected as location of one of 20,000-man "permanent tent camps." Water supply derived from 3 wells and 3½-sq.mi. drainage basin of Chorro Creek, water from latter being stored behind Chorro Dam in 208-acre-ft. reservoir. 2 chlorination plants completed, and softening plant under construction. Supply not adequate for series of dry years. Consideration being given to supply from Salinas R., 12 mi. distant, which would involve 200′ lift. Proposed supply line, 24″ or 18″ in diam., depending on whether gravity or pressure, would consist of 10 mi. of pipe, 1 mi. of lined tunnel and 7,000′ of open channel. Joint development with nearby communities requiring additional water possibility.—*R. E. Thompson.*

Sanitary Engineering at Airports. A. E. BERRY. Can. Engr.—Wtr. & Sew. **79:** 6: 90 (June '41). Extensive program of airport construction undertaken in connection with British Commonwealth Air Training Plan resulted in no. of sanitary problems. Sites selected to satisfy military requirements, complicating sanitary problem. Water supply of 40–75 g.p.d. (Imp.) per capita required. Treatment of surface waters has followed standard practice of filtration and chlorination.—*R. E. Thompson.*

Plant Management and Operation in a War Year. G. HUDSON STRICKLAND. Eng. Cont. Rec. **54:** 30: 54 (July 23, '41). Water utility integral part of war effort of nation and every precaution must be observed to maintain it in operation. This fact should be impressed on every employee so that each may be conscious of his responsibility. Constant checks on loyalty of staff necessary. Each community must plan and prepare its own defense measures and provide reasonable protection against sabotage. Public should be denied access to water works property. Possibility of air raids may seem remote but plans should be made for coping with damage which would result. Supply of parts should be kept in storage and equipment maintained in such condition that max. capacity can be obtained. Anything less than constant vigilance savors of sabotage from within.—*R. E. Thompson.*

Post-War Reconstruction. AVON E. CRISP. Wtr. & Wtr. Eng. (Br.) **43:** 114 (Apr. '41). Time should be found for consideration of those aspects of reconstructional plans most likely to affect water undertakings. Report of Royal Com. on Distribution of Industrial Population, published in Jan. '40, result of close study by technical experts. Does not mention increased burden of supplying water for this increase in pop. and industry. Movement of industrial pop. into area leads to 3 things connected with supply of water: (1) increased consumption for domestic purposes; (2) possibility of industry obtaining its own supply of water or increase of water supplied for industrial purposes by water authority; and (3) need for planning of water works to meet this increase in consumption. In regional govt. centers, to be established, regional water supply survey would necessarily form basis of decisions relating to supply. Post-war reconstructional programs might also provide trunk and feeder mains.—*H. E. Babbitt.*

TREATMENT—GENERAL

Water Treatment Plant Design. A.S.C.E. Manual of Practice No. 19. (Adopted July 23, '39). I. GENERAL ARRANGEMENT OF PLANT: In studying location and layout of any water purif. plant, no design can be considered satisfactory which does not take into account 5 main factors: (1) structural security; (2) functional efficiency; (3) esthetic values; (4) economy of design and operation; and (5) provision for future expansion. Certain inherent differences between large and small treatment plants that should be recognized by designer. First is financial, second physical, and third personal. Frequently, combination of processes or types is required to treat given water supply in best way. In simplest forms, they are: slow sand filters, rapid sand filters, softening plants, and iron and manganese removal plants. II. PRIMARY TREATMENT: *Aeration:* Removes objectionable tastes and odors, carbon dioxide, and iron and manganese. Accomplished by several methods, e.g.: (1) cascades; (2) splash trays; (3) coke beds; (4) spray nozzles; and (5) air diffusion. For cascades and splash trays, fall of water varies from 3′ to 10′. Spray nozzles need pressure of about 10 lb. per sq.in. Air diffusers require about 0.05 to 0.10 cu.ft. of air per gal. of water treated. Power required will be about 1 kw. per 1 m.g.d. of capac. *Mixing and Flocculation:* Function of initial, rapid mix is to disperse applied chemical throughout water. Rapid diffusion of chemicals accomplished by many devices, e.g.: (1) baffled channels; (2) inlet pipes or conduits—some with internal baffles; (3) raw-water pumps; (4) turbo-mixers; (5) mechanical mixers or agitators; (6) hydraulic jump; (7) aerators; (8) throttled gate valves or sluice gates; (9) Venturi meter tubes; (10) baffled chambers; (11) tangential or spiral flow tanks; and (12) air agitation in tanks or channels. Time required for rapid mix is about 1 min. where velocity or turbulence is sufficient. Any velocity greater than 5′ per sec. should be sufficient. Ave. installed h.p. for mechanical stirrers, turbo-mixers and like is $\frac{1}{4}$ h.p. per 1 m.g.d. *Flocculation:* Moderately large, dense, and heavy floc obtained by continued stirring. Optimum velocity found to be from 0.5′ to 1.0′ per sec. Time required for gentle agitation between 10 and 60 min. Floc will settle usually at velocities less than 0.3′ per sec. and will be broken up by velocities greater than 2.5′ per sec. Two general classes of flocculation basins—those using kinetic energy of water flowing through plant and those stirred by mechanical devices. Another type utilizes vortex action induced in cylindrical tank by introducing water tangentially at top or bottom and taking it off at center, either top or bottom. By far most satisfactory flocculation is obtained by mechanical stirring. Stirring devices of two types—those revolving on vertical shaft and those on horizontal shaft, former being more commonly used. Power requirements of either type are about $\frac{1}{4}$ to $\frac{1}{3}$ h.p. per 1 m.g.d. *Baffled Chambers:* Either over-and-under or around-the-end type baffles may be used. Velocities should be kept within 0.3′ to 1.0′ per sec. *Spiral and Tangential Flow Chambers:* diam. should not exceed 40′ and the depth should equal or exceed diam. Velocities should lie between 0.5′ and 0.75′ per sec. Flocculation chamber agitated by air can be any reasonable shape. Depths from 7′ to 12′ satisfactory. Quantity of air required function of surface area of tank, and is about 0.5 cu.ft. per min. per sq.ft. of tank area. Mechanically agitated flocculation basins usually square or rectangular, proportioned to suit equipment used. Depth is limited only by practical construction. Simple, straight paddles found very effective. Proper speed depends on type of paddle and character of water and floc. In general, should be as high as possible without breaking up floc. *Sedimentation:* When water is allowed to stand quiescent, or is conducted through basins at low velocity, foreign matter, ordinarily carried in

suspension, settles by gravity to bottom. Whether these particles have sufficient velocity to move forward not definitely established. Optimum condition obtained when cross-section of incoming water advances uniformly to point of discharge. Both circular and rectangular basins well adapted to sedimentation with aid of coagulants, latter being used where continuous sludge removal not required. Head required almost negligible. 2- to 4-hr. theoretical retention enough for proper preparation of water for filtering. Ave. velocity of 1.0′ to 3.0′ per min. low enough if cross-currents and short circuiting can be prevented. Most rectangular basins have length about twice width. Ratio could be greatly increased with beneficial results. Ave depth of basins about 16′, with range between 6′ and 25′. Not believed that baffles required for most efficient results. III. FINAL TREATMENT—FILTRATION: Several theories advanced to account for removal of bacteria and fine suspended particles when space between sand grains is so much larger than substances removed. When floc reaches sand most of it enters interstices between sand grains. Relationship among size of sand, depth of penetration, and quantity of floc that can be retained in filter not generally known. With given stirring velocity in coagulation and with given rate of filtration, may be expected that, when temp. drops, smaller floc particles will be formed in flocculation, and floc will penetrate deeper into filters. *Slow Sand Filters:* Very few have been built in U. S. since 1915. *Rapid Sand Filters:* 30″ seems to have been accepted as proper depth of sand but more recently growing tendency to reduce this to 24″. Has been demonstrated that depth of sand should be greater for coarse sand. Filtering abilities of all grades of sand, up to their respective critical depths, are equal. Ideal gravel layer is one in which gravel is nearly spherical in shape and in which there is uniform decrease in size from top to bottom. On small filters, containing 24″ of graded sand having uniformity coef. of more than 2, rates of applying wash water, to be efficient, will be from 24″ per min. vertical rise for top sand between 0.25 and 0.35 mm., to 40″ per min. vertical rise for top sand between 0.95 to 1.35 mm. Electric-driven centrifugal pumps generally used for washing filters. Capac. of such pumps should be from 7.5 to 12 times rated capac. of filters. Where wash water is retained in elevated tank, ave. tank capac. in practice is about 70,000 gal. per mil.gal. of one filter unit capac. In list of 55 plants, most of tanks were 35′ or less for height of tank bottom above filter surface. To secure accurate record of quantity and rate of wash, Venturi meter with recording chart desirable. Height of wash-water trough above sand should be slightly above max. sand rise. Also desirable to space troughs closer than is customary ave. of about 4.5′ in clear. Two general types of filter bottoms—those that direct flow of water through pipes and restricted orifices and those in which water has unrestricted access to under part of filter, and distribution is obtained by passing it through small orifices or by converting pressure head into velocity head. Most concrete walls for filter tanks are 9″ to 12″ thick, designed as slabs supported top and bottom. Ample covering for protecting reinforcing bars should be provided. Construction joints should be so planned and placed that section can be reinforced by rods of single length. Keyways should be planned in advance of construction, capable of taking entire thrust. Effect of changes in temp. should receive careful consideration. Firmly believed that no advantage in rough filter walls. Desirable to use cast iron for piping as much as possible. Much confusion will result unless carefully planned system devised for handling the many different kinds and sizes of specials required. Valves in large filter plants generally controlled hydraulically. Sluice gates seldom required to withstand heavy pressure, but, to secure tightness, should be made of best quality of cast iron. Fixed-rate controllers particularly suited to plants where hourly demand nearly constant. In most plants, rate controllers designed to operate automatically. Indicating and operating devices, frequently made

of gray Tennessee marble, with 2 removable panels front and back, generally placed on operating tables. Filter buildings offer considerable resistance to heating as they are surrounded on all sides by conditions that cause high heat losses. Only in a few particulars should filter plant lighting be different from that of other buildings. Probably no particular in which designing engineers more likely to underestimate plant requirements than in matter of storage space. IV. CHEMICAL AND OTHER AGENTS USED IN WATER TREATMENT PROCESSES: As coagulants, aluminum sulfate, sodium aluminate and ferric sulfate have already attained wide use. Quicklime and hydrated lime, together with soda ash, used extensively as softening agents. Equipment for storage, measuring or feeding chemicals should be arranged as compactly as possible. Ample space should be provided for handling shipping containers. Particular attention must be paid to handling of chlorine, ammonia and sulfur dioxide. Becoming common practice to use conveyors to move chemicals into and within plants. Chemicals may be stored either in bulk or in shipping containers, depending on chemical, rate of use and physical conditions. Has been customary to plan size of solution storage tanks to last for one shift or one day. Always preferable to augment rate of solution of chemicals with vigorous agitation. Steel tanks suitable for slaking lime. Materials most widely used in handling chemical solutions are iron, lead, rubber hose, acid-resisting bronze, and concrete. In one type of solution feed equipment, chemical is measured dry and then discharged into stream of water which dissolves and carries it in solution to point of application. Other type consists of batch preparation of solution of known strength, followed by measurement of rate of flow of that solution. Two general types of dry feed equipment—that which regulates chemical flow volumetrically and that which governs it gravimetrically. In case of gases, measurement is effected through calibrated orifices.—*H. E. Babbitt.*

Trends of the Past Year in Water Purification. NORMAN J. HOWARD. Can. Engr.—Wtr. & Sew. **79:** 1: 13 (Jan. '41). Detailed, illustrated review of progress during '40 in field of water supply and purif. In Ontario, no plants of any magnitude were constructed, but govt. approval was given to 120 minor projects costing $834,000. Throughout Canada, more than 100 airports and military camps were placed in commission, each with its attendant problem of water supply. Control of water pollution is being given increasing attention. Current trends in America are toward more extended use of mechanical aids to flocculation, greatly increased use of surface agitation in washing of filters, more widespread application of cathodic protection for tanks and distr. systems, and more general use of sodium hexametaphosphate for prevention of corrosion and after-precipitation. Importance of adequate conditioning of water is becoming increasingly evident. Greater variety of types of underdrains have been employed in recent plants. Types employed have included Wheeler bottoms, concrete duplex underdrains, slat-type bottoms, grids of transite pipe, and porous filter plates. Surface agitation during washing is employed at more than 60 filter plants. Benefits claimed include elimination of mud balls, longer runs, greatly reduced wash water and less trouble due to taste caused by decomposing organic matter from within filters. Country-wide interest in super-chlorination has followed wide publicity given to break-point chlorination. Use of activated carbon for taste control is being extended throughout world. Tendency among smaller plants to apply small dose continuously as protection against intermittent taste and odor. Corrosion control received more attention than any other phase of water treatment. Well over 600 water tanks have been equipped for cathodic protection. Calgon is employed in some 150 municipalities for prevention of after-troubles in distr. systems. Bacterial depreciation of water in distr. systems also received much consideration. No indication in

any city where such trouble has been reported that public health has been involved. Consequently it can be assumed that, if water entering distr. system is adequately treated and not subjected to secondary contamination, such depn. is of no san. importance. Protective grounding of elec. wiring is still subject of much controversy.—*R. E. Thompson.*

Exhibits and Descriptions of Some New Water Treatment Equipment. CHARLES P. HOOVER. Ohio Conf. W. Purif. 20th Ann. Rept. ('40) p. 109. Following described and illustrated: (1) The Scott Underwater Burner or Carbonator, which burns gas under pressure of 7–10 lb. per sq.in. and is submerged in water to be carbonated. (2) Pressure-type gas producer in which compressor precedes generator, thus avoiding corrosion difficulties. Coke used as fuel and gas contains 15–18% carbon dioxide. (3) Copper sulfate feeding device consisting of turbine pump direct-connected to gasoline engine, hopper for powdered copper sulfate, rotor feeder, ejector and nozzle which will spray soln. to width of 50′. With boat travelling 15 m.p.h., approx. 1.5 acres can be treated per min. Anticipated rate of application is 7 lb. per acre of surface.—*R. E. Thompson.*

Recent Developments in Water Treatment. S. B. APPLEBAUM. Power Plant Eng. **45:** 69 (Apr. '41). Spaulding precipitator, degasifiers and de-aerators described in connection with removal of physical impurities in water to be used for steam generating purposes.—*T. E. Larson.*

Water Treatment Economies. F. J. MATTHEWS. Colliery Eng. **17:** 197 ('40). Discusses economies which may be effected in treatment of water supplies for collieries. When two or more types of water obtained from different parts of one pit, frequently possible to obtain water of better quality by blending them. Blending must be controlled by regular chem. analyses. Main types of water acid, alkaline, and hard or neutral waters. Acid and alkaline waters may be used to neutralize one another, and alkaline waters may be blended with hard waters as sodium carbonate in alkaline water will react with calcium sulfate in hard water. Acid waters may be used for neutralizing alkalinity in waters softened by sodium zeolite. When water treated by hydrogen zeolite process, acid water obtained may be blended with raw alkaline water instead of with water which has been passed through sodium zeolite. Under certain conditions water withdrawn from boiler, and which contains alkali, may be used for softening raw feed water. Total conc. of salts in boiler feed water can be reduced by mixing water with a high content of salts with one which has low salt content. Softening with hydrogen zeolite substantially reduces conc. of salts. Return of condensate also helps reduce salt content. Treatment of water in boiler with mixture of inorganic and organic materials, e.g., soda ash and a colloid, may be used, but this increases amt. of sludge in boiler and more frequent blow-down required. Use of sodium hexametaphosphate to prevent deposition of carbonates in cooling water systems discussed—*W. P. R.*

Water Treatment for Chemical Impurities. S. B. APPLEBAUM. Power Plant Eng. **45:** 74 (June '41). Carbonaceous zeolites have made alkalinity removal by zeolites possible. Mag-de-Sil process, involving $Mg(OH)_2$, successfully removes SiO_2 by adsorption. De-Acidite, organic material, successfully removes anions SO_4^{--} and Cl^-. When used in conjunction with hydrogen zeolites, low solids effluent can be obtained economically, providing original dissolved solids appreciably less than 500 p.p.m.—*T. E. Larson.*

Experience in the Use of Calgon—Discussion. Ohio Conf. W. Purif. 20th Ann. Rept. ('40) p. 95. R. H. SANDWISCH: Application of 1 p.p.m. Calgon (sodium hexametaphosphate) at Woodville, Ohio, appeared to stabilize water, but after 5 mo. operation, white deposit in meters rendered them inoperative. Exam. of water indicated that metaphos-

phate was being converted to orthophosphate before water reached outlying districts. Increasing dosage to 2 p.p.m. appears to have corrected difficulty, 0.5 p.p.m. metaphosphate being found in distant part of distr. system. Treatment plant is of pressure type and necessity of recarbonating in settling tank results in poorly settled water being applied to filters. Prior to using metaphosphate, pumps, operating at rate of only 2 mil.gal. per mo., had to be cleaned with acid at intervals not exceeding 3 weeks. After 14 mo. operation using metaphosphate, pumps free from incrustation and filter runs more than doubled. Hardness of tap water, however, increased from 95 to 144 p.p.m. *Ibid.* p. 96. CHARLES P. HOOVER: Expts. on corrosion of hot water tanks continued at Columbus and photographs shown of 6 tanks through which water treated in various ways, including application of 0.25–1.0 p.p.m. metaphosphate and 1 p.p.m. phosphotex, and heated to 140–150°F., passed for 1 yr. Visual inspection indicated that metaphosphate played no part in preventing corrosion of tanks. From these and other expts. and actual experience, concluded that good protective scale will form in galvanized hot water tanks if water heated to not higher than 150°F. and if at least 25–30 p.p.m. of alkalinity as normal carbonates present and water contains no bicarbonates. Suitable protective scale not formed when normal carbonates low, even if caustic alkalinity present, or if water low in normal carbonates and high in bicarbonates. Treatment of Columbus supply with metaphosphate commenced in Apr. '39 for purpose of stabilizing water and enabling water of pH 9.7 to be supplied without danger of excessive scale formation, it being believed that water of this high pH value and containing 25–30 p.p.m. normal carbonates would minimize corrosion. Complaints of corrosion of hot water tanks reduced to min. and corrosion that does occur usually due to over-heating. Dosage of metaphosphate employed, 0.25 p.p.m. during warm months and 0.5 p.p.m. during winter, when finished water less stable due to slowing up of softening reactions; O content higher; and corrosion troubles more pronounced. *Ibid.* p. 99. OWEN RICE: Analyses of scale formed in Columbus tank expts. presented. Apparent that galvanizing on new tanks effective in protecting iron at high pH values as well as at low and least effective in range approximating "stability pH," 8.0–9.5. In this range, zinc removed fairly rapidly, while at lower pH values almost unaffected and at higher pH levels, protective coating formed. Coating on tanks found to consist almost entirely of zinc oxide and carbonate, with approx. 8% magnesium silicate and 3% calcium carbonate. Exam. of 2 hot water tanks, in use in Columbus 3 and 18 yr., respectively, showed complete or partial healing over of rust tubercles which practically covered interior of both tanks. Believed, therefore, that use of metaphosphate rather than increased alkalinity of water chiefly responsible for diminution of red water in hot water tanks. Equally good results obtained elsewhere with metaphosphate without change in pH or alkalinity. Possibility that elimination of red water by increasing pH merely due to precipitation of corrosion products at point of corrosion discussed. Generally accepted that raising pH increases pitting tendency although reducing total corrosion. Calgon produces immeasurably thin film, presumably iron phosphate, protective at all pH values above 5.0. Does not interfere with chlorination or zeolite softening. *Ibid.* p. 102. GEORGE D. NORCOM: Increasing pH value to point of calcium carbonate equilibrium reduces red water complaints in cold water systems about 90%.—*R. E. Thompson.*

Experiments on Removal of Fluorine From Domestic Water Supplies. OSMAN JAMES WALKER. Can. Engr.—Wtr. & Sew. **78**: 12: 20 (Dec. '40). Fluorine content of water depends on stratum of soil or rock through which it flows. Generally speaking, if strata contain phosphates derived from fluorine-containing apatite, water will contain sufficient fluorine to cause mottling of teeth, while strata low in phosphates will carry water containing little fluo-

rine. Fluorine cannot be removed from water by precipitation as there is no fluoride whose solubility is such that residual fluorine is less than 1 p.p.m. Combination of selective adsorption and anion exchange offers best possibilities. Experimental work on use of activated alumina, tricalcium phosphate, crushed bone and magnesium oxide have been reported in literature. Two methods were employed in investigation: (1) percolation method, in which water was passed through column of material; and (2) "spoon and bucket" method, in which definite wt. of material was added to water, stirred, allowed to stand overnight and water then drawn off—procedure being repeated until fluorine-removing power was exhausted. Latter method was favored, as more easily applicable in country households. Edmonton tap water was used in expts., sufficient sodium fluoride being added to give required fluorine content. Results are shown in curves, in which liters of water treated per 100 grams of material (roughly gal. per lb.) are plotted as abscissas and p.p.m. fluorine in treated water as ordinates. Some 27 materials were investigated and rejected as unsuitable. Promising results were obtained with magnesium and aluminum oxides and calcium and aluminum orthophosphates. Freshness and method of drying materials affected their efficiency. For comparison, runs were made on 2 products which have been used by National Aluminate Corp., an activated alumina (Defluorite A) and a tricalcium phosphate (Defluorite B), latter having now superseded former. In first series, water containing 8 p.p.m. fluorine was passed through about 50 cm. of material contained in 2 cm. tubes. Materials used were alumina dried under different conditions and Defluorite A. Only one of these, an alumina prepared by precipitation of hydroxide on shredded filter paper, air-drying for 2 days and heating for 12 hr. at 190°C., gave favorable results—100 grams lowered fluorine content of more than 100 liters from 8 to less than 1 p.p.m. In other series, second procedure was employed. Good results were obtained with hydrated alumina treated in different ways, with mixture of co-precipitated alumina and calcium carbonate, and with aluminum phosphate from several sources. Magnesium oxide, Defluorites A and B and tricalcium phosphate from other sources were also tried. Freshly prepared aluminum phosphate gave results of same order as Defluorite B and much greater than 2 purchased brands. One lb. of alumina dried at 81°C. lowered fluorine content of 140 gal. of water from 4 to less than 1 p.p.m. and 1 lb. of prepared aluminum phosphate similarly reduced fluorine content of 100 gal. Air-dried alumina was also effective. Funds have not been available for large scale expts., but units furnished by National Aluminate Corp. have been placed in service at 3 points. Units consist of closed vessels with inlet tube at top and outlet tube at bottom and contain 10 lb. 20–40 mesh tricalcium phosphate (Defluorite B). When exhausted, material can be revivified by removing and treating with sodium hydroxide, followed by hydrochloric acid or carbon dioxide. When operated under pressure, rate of flow should not be greater than 3 g.p.m.; when operated by gravity, flow is about 0.5 g.p.m. Results are shown in tabular and graphical form.—*R. E. Thompson.*

Sulfur Compounds in Water Treatment. J. B. CHATELAIN. Tex. W.W. Short School. **22:** 90 ('40). Sulfur dioxide may be used for preparation of ferrous sulfate or ferric sulfate from scrap iron at cost less than production of corresponding chloride. Sulfur dioxide conveniently obtained by burning sulfur in much improved burners that require little attention and are easily regulated within narrow limits. Alum may be made by action of sulfur dioxide on bauxite ore suspended in water. Sulfur dioxide will destroy taste and odor and can be successfully used for dioxidizing boiler water and cleaning filter sands.—*O. M. Smith.*

The Role of Ammonia in the Treatment of Water With "Chloramines." R. BUYDENS. Rev. Hyg. (Fr.) **61:** 576 ('39–'40). Discusses action of ammonia in ammonia-chlorine treatment of water. Am-

monia is usually added first. Ratio of ammonia to chlorine used varies from 1:4 to 1:1. Results obtained are usually explained on assumption that chloramines formed do not react with organic matter as rapidly as does chlorine. Koschkin has suggested that ammonia combines with organic matter and causes it to combine less readily with chlorine. Has been shown that in absence of organic matter, rate of disappearance of chlorine is increased, not decreased, by ammonia. Author considers that effect of organic matter on ammonia-chlorine treatment of water is explained if chlorine reacts equally rapidly with ammonia and bacteria, but reacts more rapidly with ammonia than with organic matter. Chlorine which has combined with ammonia still has bactericidal action, but disinfection is slower than with free chlorine —*W. P. R.*

Chlorination Improvements as Exemplified in the Toronto Water Purification Plants. RUDOLPH E. THOMPSON. Can. Engr.—Wtr. & Sew. **79:** 6: 54 (June '41). Brief outline of history of purif. in Toronto. System in operation from 1841 purchased by municipality in 1873. Earliest attempt at purif. use of infiltration basin, which proved failure. Chlorination with bleaching powder adopted in '10 and filtration in '12. Chlorination plant revamped for use of liquid chlorine in '17 and pre-chlorination adopted in '21. Latter enabled alum to be applied for clarification only and effected saving in operating costs in excess of 40,000 per annum. Research showed that tastes in chlorinated water were due to phenol and that super-chlorination would be effective remedy. This process has been employed since '26–7 and taste now rarely occurs. Provision made at new Victoria Park Plant for super- and de-chlorination and for use of activated carbon should it be required.—*R. E. Thompson.*

Providence Improves Its Treatment Plant. PHILIP J. HOLTON, JR. W.W. Eng. **94:** 60 (Jan. 15, '41). Recent extensions and improvements to Providence, R. I., purif. plant at cost of $1,131,380 eliminate all danger of curtailment during hurricane or other disturbances and provide for uniform filter operation. Coagulation basins, originally unlined, were lined with concrete mat and drain channels installed for sludge removal. Disturbance of settled sludge due to wave action in high winds improved by increasing depth of basins from 10′ to 17′. Power transmission system placed underground. 4 new filters added. Hydraulically operated valves changed to electric-motor-driven valves and entire plant control brought to central control broad in effluent gallery. Chemicals brought to plant in bulk in special transfer truck and handled with pneumatic materials-handling system. Machinery for handling lime and dry chemicals located on fourth floor of head house structure where 2 new chlorinators also housed. Ferric chloride fed from basement; stored there in rubber-lined tanks. Work completed in Aug. Since then chemical cost has reached all time low of $1.27 per mil. gal. in Sept. 45% of cost ($509,121) contributed by P.W.A.—*Martin E. Flentje.*

Water Treatment at Marietta, With Special Reference to the Horizontal Type of Spaulding Precipitator. H. R. EGGLESTON. Ohio Conf. W. Purif. 20th Ann. Rept. ('40) p. 21. In Dec. '39, filter plant which had served Marietta, Ohio, for 35 yr. abandoned and new 2.8-m.g.d. treatment plant, consisting of 4 precipitators, recarbonation equipment, 4 filters with Wagner underdrains, and chlorinator placed in operation. Supply drawn from 3 wells, intake being provided in Muskingum R. in case of emergency. One well suffices for ave. demand of 1.5 m.g.d. Precipitators rectangular concrete basins, 15′ x 30′ in area and 18′ deep, each provided with steel baffle, below which is horizontal agitator which can be operated at 4 speeds ranging from 2.5 to 6.75 r.p.m. Retention period approx. 90 min. Sodium aluminate found to be more effective and economical coagulant than alum. Top of the sludge blanket 9–10′ below weirs and sludge concentration in blanket region ranges from 1.0 to 2.5% by wt. Water recarbonated, with carbon dioxide derived from burning natural gas, prior to filtration. Filter effluent has turbidity of 5–8 p.p.m. when precipitators operating

properly and filter runs average about 72 hr. Raw water bacterial count never exceeded 6 and coliform organisms never detected, consequently chlorinator not in operation. Filter effluent stabilized with Nalco No. 18 (sodium monopyrotetrametaphosphate), dosage being approx. 5 p.p.m. During period May–Sept. '40, monthly ave. lime, soda ash and sodium aluminate dosages 9.2–12.03, 1.98–2.28 and 0.39–0.46 g.p.g., respectively, and chemical cost varied from $13.05 to $16.48 per mil.gal. Monthly ave. hardness of delivered water ranges from 83 to 95 p.p.m. and pH from 9.4 to 9.6. Raw water hardness varies from 259 to 304 p.p.m. *Discussion. Ibid.* p. 27. FRANK S. TAYLOR: Data presented regarding operation of new 1.5-m.g.d. softening plant of Montpelier, which includes 2 parallel vertical precipitators. Natural iron content of water produces excellent floc. Ave. speed of agitator 3 r.p.m. and sludge concentration in blanket varies from 0.8 to 1.4% by wt. Sludge content of drawoff averages 3%, with max. of 5%. In Aug., total hardness reduced from 334 to 89 p.p.m. with ave. dosages of 14.94 g.p.g. of lime and 0.94 of alum. *Ibid.* p. 28. G. ALBRO HALL. Operating data for Shelby and West Mansfield softening plants summarized. At former, detention period in conical concrete precipitator about 2 hr. at present rate of operation of 1 m.g.d. (nominal capac. 2 m.g.d.). "Ferri Floc" (ferric sulfate) found more effective and economical coagulant than alum. At present, dosage of 0.5 g.p.g. giving settled water turbidity averaging slightly less than 5 p.p.m. During 14 mo. operation, well water hardness averaged 685 and that of filtered water 167 p.p.m. West Mansfield plant has capac. of 100 g.p.m. Precipitator is octagonal in shape and lime, soda ash and crystal alum employed in treatment process. Solids content of sludge blanket varies from 0.6 to 0.8%. Removal of fluorides in proportion to removal of magnesium hardness—50% reduction in magnesium accompanied by reduction in fluorides from 2.0 to 1.0 p.p.m. During 8 mo. operation, well water hardness averaged 605 and filtered water 161 p.p.m.—*R. E. Thompson.*

Operation of a Small Water Treatment Plant. J. M. LLOYD. Tex. W. W. Short School. **22:** 86 ('40). Tyler, Tex., supplied by lake of 177 acres and has filter plant of 3½ mil.gal. capac. Lake an old one with ave. depth of 10′, consequently taste and odor predominate. In addition, water contains considerable amt. of manganese. Excessive clogging of filter and "manganese balls" 2′ in diam. frequent occurrences until yearly treatment of chlorine adopted. After strong solution of chlorine, 250 p.p.m., used for period of 10 days, manganese and mud silt practically all eliminated. Practice of yearly check-up of all mechanisms in plant reduced operating cost in power consumption sufficiently to justify inspection. Odor and taste problem solved by super-chlorination, using 7 p.p.m. of Cl, and monthly treatment of lake with copper sulfate. Hourly tests for chlorine and alkalinity and bact. tests twice daily regular routine. In discussion, difficulty of lone employer of small plant to be all-purpose man, operator, meter reader, chemist, and manager emphasized.—*O. M. Smith.*

The Continuous Purification and Heating of Swimming Bath Water. B. M. HILLS. J. Inst. Heat. & Vent. Engrs. (Br.) **8:** 71 ('40). Ministry of Health stipulates complete turnover every 4 hr. for indoor pool of 80,000 gal. Water drawn from bottom of deep end, strained, filtered, and heated to 75°F. Aerated and chlorinated water re-enters pool near surface at shallow end. Duplicate pump sets working at 50% efficiency for economy in working costs and wear of moving parts suggested. Filters handling 200 gal. per sq.ft. per hr. made up of granular quartz supported on granite chippings. Layers cleaned when pressure difference between inlet and outlet of reaches 12 lb. per sq.in. Heating of outdoor pool water to 65–70°F. by calorifier. method to prolong bathing season becoming more popular.—*P. H. E. A.*

Treated Water Facilities Supplant Tank Wagon Supply. ANON. Eng. News-Rec. **126:** 174 (Jan. 30, '41). Hallock, Minn., is situated in area underlaid by beds of salt and, as result, ground water is too

highly mineralized for domestic use. Practice has been to haul water to town in tank wagons at cost of 5¢ per gal., but, with aid of P.W.A., 288,000-g.p.d. plant was recently completed, at cost of $82,497, for purifying and softening impounded water obtained from the Two Rivers. Lime-soda ash process is used and plant consists of compressed-air aerator to remove gases and provide flash mix, mechanical stirrers, dual sedimentation basins provided with sludge-collecting pipes, recarbonation basin in which flue gases are passed through pipe grids, and 2 gravity sand filters 8′ in diam. Ammonia-chlorine will be used for sterilization and provision was made for adding activated carbon.—*R. E. Thompson.*

Electro-Automatic Pressure Filtration and Softening Plant. ANON. Wtr. & Wtr. Eng. (Br.) **43:** 89 (Mar. 10, '41). "EDITORIAL NOTE: Name of water authority and location of plant have been omitted for censorship reasons, but this information will be furnished [by British publication] to responsible engrs. who may be interested." Proposed modifications to water system were: (1) to augment flow from collecting drains, when insufficient, by taking water from brook which flows through works; (2) to install coagulation, mechanical filtration, softening and sterilization plant; (3) to construct new covered treated water reservoir at higher elevation; and (4) to install automatic booster plant for supplying treated water to high level system. Water is drawn from either reservoir by electric-driven centrifugal pump and delivered to two "Permutit" automatic vertical pressure filters each 6′6″ in diam. Next step in treatment cycle is softening carried out in Permutit automatic base-exchange softener 5′6″ in diam. After softening, water sterilized by addition of small quantity of sodium hypochlorite. Treated water conveyed to covered concrete reservoir with a capac. of 100,000 gal. (Imp.). To supply water to high level system, electric-driven booster pump, capable of delivering max. quantity of 4,000 gal. (Imp.) per hr. available. Complete automatic control system adopted ensures plant's at max. efficiency at all times.—*H. E. Babbitt.*

Errata

In Fig. 13 on p. 1352 of the August JOURNAL, the second symbol from the bottom along the east bank of the Genesee River should show as the symbol for 2.2 to 23 M.P.N. coliform organisms.

It is also to be noted that the symbol for 0.1 p.p.m. or less and the symbol for 0.5 p.p.m. or greater used in the maps and legends of Figs. 3 and 4 are the opposite of the symbols used in Fig. 2.